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ABSTRACT

These instructor materials for an aviation maintenance technology course contain five instructional modules. The modules cover the following topics: performing aircraft ground handling and servicing, using hand and power tools and precision measuring instruments, identifying and selecting aircraft hardware, fabricating and installing rigid and flexible fluid lines and fittings, and computing and recording aircraft weight and balance. Each module contains some or all of these nine basic components--a module introduction and objective, performance objectives, instructor's module implementation guide, technical information supplements, workbook supplements, project guides, theory test, answers to theory test and workbook supplements, and a practical test. These materials were developed through a cooperative effort of airframe and powerplant mechanics, general aviation industry representatives, Federal Aviation Administration representatives, and vocational educators in Oklahoma to provide a comprehensive program in aviation maintenance technology. (KC)

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AVIATION MAINTENANCE TECHNOLOGY

GENERAL

G104 TECHNICAL MECHANICS

INSTRUCTOR MATERIAL

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MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A



STOP



COME AHEAD



EMERGENCY STOP



CUT ENGINES



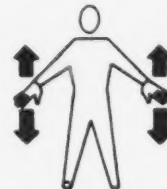
START ENGINES



PULL CHOCKS



INSERT CHOCKS



SLOW DOWN

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MODULE CONTENTS

- A. Introduction and Module Objective
- B. Specific Objectives
- C. Instructor's Module Implementation Guide
- D. Technical Information Supplements
 - 1. Technical Information Supplement #1--Terms and Definitions
 - 2. Technical Information Supplement #2--FOD, Propeller, and Rotor-to-Person Safety
 - 3. Technical Information Supplement #3--Proper Use and Care of Rope
 - 4. Technical Information Supplement #4--Aircraft Fueling
- E. Transparency Masters
 - 1. Transparency Master #1--Helicopter Safety
 - 2. Transparency Master #2--Helicopter Safety (Continued)
 - 3. Transparency Master #3--Engine Intake and Exhaust Hazard Areas
 - 4. Transparency Master #4--Tiedown Dimensions
 - 5. Transparency Master #5--Tornado Frequency
 - 6. Transparency Master #6--Continental U.S. Storm Belts
 - 7. Transparency Master #7--Position of Taxi Signalperson
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MODULE CONTENTS

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3. Workbook Supplement #3--State Facts Related to Tiedown Procedures
4. Workbook Supplement #4--State Facts Related to Aircraft Jacking and Hoisting
5. Workbook Supplement #5--State Facts Related to Aircraft Towing
6. Workbook Supplement #6--State Facts Related to Aircraft Servicing and Ground Support Equipment
7. Workbook Supplement #7--State Facts Related to Aircraft Fueling and Defueling

G. Answers to Workbook Supplements

H. Project Guides

1. Project Guide #1--Perform Aircraft Tiedown
2. Project Guide #2--Perform as Signalperson for Taxiing Aircraft
3. Project Guide #3--Perform Reciprocating Engine Run-ups
4. Project Guide #4--Perform Aircraft Taxiing

I. Theory Test

J. Answers to Theory Test

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INTRODUCTION

Aircraft maintenance technicians devote a portion of their aviation career to working with ground support equipment and ground handling of aircraft. The complexity of support equipment and the hazards involved in ground handling of expensive aircraft require that maintenance technicians possess a detailed knowledge of safe procedures used in aircraft servicing, taxiing, engine run-up, and in the use of ground support equipment.

MODULE OBJECTIVE

After completion of this module, you will be able to perform aircraft tiedown, identify FAA standard hand signals, perform as a singalperson for taxiing aircraft, and identify aircraft fuels. You will also be able to perform reciprocating engine run-ups and aircraft taxiing. You will demonstrate this knowledge by completing the procedures outlined in the workbook supplements and project guides. You will further demonstratrte this knowledge by scoring a minimum of 85 percent on the module theory test.

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SPECIFIC OBJECTIVES

After completion of this module, you will be able to:

- | | |
|---|---|
| 1. Match terms related to aircraft ground handling and servicing to their correct definitions. (1) | Technical Supplement #1
Workbook Supplement #1 |
| 2. State facts related to safety during aircraft ground handling and servicing. (1) | EA-ITP-G 7:I:1-7
EA-ITP-GW 7:1,2
AC-65-9A 11:500-508
Technical Supplement #2
Workbook Supplement #2 |
| 3. State facts related to aircraft tiedown procedures. (1) | EA-ITP-G 7:I:7-13
EA-ITP-GW 7:2
AC-65-9A 11:508-517
Technical Supplement #3
Workbook Supplement #3 |
| 4. Perform aircraft tiedown. (3) | Project Guide #1 |
| 5. Select true statements related to aircraft jacking and hoisting. (1) | EA-ITP-G 7:I:13-14
Workbook Supplement #4 |
| 6. Select facts related to taxiing an aircraft. (1) | EA-ITP-G 7:I:14-17
EA-ITP-GW 7:7
AC-65-9A 11:520-523 |
| 7. Identify standard FAA hand signals used for ground handling fixed-wing and helicopter-type aircraft. (1) | EA-ITP-G 7:I:15,16
EA-ITP-GW 7:2-6 |
| 8. Perform as a signalperson for a taxiing aircraft. (2) | Project Guide #2 |
| 9. Select statements related to the towing of aircraft. (1) | EA-ITP-G 7:I:17
AC-65-9A 517-519
Workbook Supplement #5 |
| 10. State facts related to aircraft servicing and ground support equipment. (1) | EA-ITP-G 7:I:17
AC-65-9A 517-519
Workbook Supplement #6 |

SPECIFIC OBJECTIVES

- | | | |
|-----|---|---|
| 11. | Identify aircraft fuels. (2) | EA-ITP-G 7:I:20
EA-ITP-GW 7:7
Technical Supplement #4 |
| 12. | State facts related to fire hazards involving aircraft fuels. (1) | EA-ITP-G 7:I:21
Technical Supplement #4 |
| 13. | List the three contaminants which commonly occur in aircraft fuel. (1) | EA-ITP-G 7:I:22,23 |
| 14. | Select statements related to aircraft fuels, fueling, and defueling procedures. (1) | EA-ITP-G 7:I:23,24
AC-65-9A 497-500
Workbook Supplement #7
Technical Supplement #4 |
| 15. | Select true statements related to safety when fueling or defueling aircraft. (1) | EA-ITP-G 7:I:24,25
Technical Supplement #4 |
| 16. | Select statements related to engine run-up procedures. (1) | EA-ITP-G 7:I:25,26
AC-65-9A 11:489-495 |
| 17. | Perform reciprocating engine run-up. (2) | Project Guide #3 |
| 18. | Perform aircraft taxiing. (2) | Project Guide #4 |

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INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module

A. Films

1. Hand Prop Accident
2. Prop Strike
3. Electrostatic Grounding

(NOTE: These films are available from Jay Nelson, FAA Southwest Flight Standards District Office 67, Wiley Post Airport, Bethany, Oklahoma 73008.)

B. Booklet - General Aviation Ground Operation Safety Handbook

(NOTE: This booklet is available from the National Safety Council, 444 North Michigan Avenue, Chicago, Illinois 60611.)

II. Implementation Suggestions

(NOTE: Have students read material related to the specific objectives. Workbook supplements may be completed as homework assignments.)

Estimated Teaching Time	Theory	Lab
Objective 1	Discuss the terms and definitions. Use Technical Information Supplement #1. Have students complete Workbook Supplement #1 as a homework assignment.	
Objective 2	Explain safety practices related to aircraft ground handling and servicing. Tell the students the symbol for class D fires is a yellow star, not a brown star as shown in AC-65-9A. Show Transparency Masters #1-#3. Have students complete Workbook Supplement #2. Show films <u>Hand Prop Accident</u> and <u>Prop Strike</u> .	

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objective 3	Explain aircraft tiedown procedures. Use Transparency Masters #4-#6. Have students complete Workbook Supplement #3 and EA-ITP-GW 7:1,2.	
Objective 4	Discuss Project Guide #1. Answer any student questions prior to the performance of Project Guide #1.	
Objective 5	Explain procedures for aircraft jacking and hoisting. Have students complete Workbook Supplement #4. Emphasize manufacturer's specifications for procedure.	
Objective 6	Explain how to direct a taxiing aircraft. Explain how to operate a taxiing aircraft. Have students complete EA-ITP-GW 7:7.	
Objective 7	Demonstrate the FAA hand signals used for directing fixed-wing and helicopter-type aircraft. Use Transparency Masters #7-#11. Have students complete EA-ITP-GW 7:2-7 (question 9).	
Objective 8	Discuss Project Guide #2. Answer any student questions prior to the performance of the project guide. (See next page for additional information to modify Project Guide #2, if needed.) Have students complete Project Guide #2. Discuss, as a class, the project guide after it is completed.	
Objective 9	Explain the procedures for towing an aircraft. Have students complete Workbook Supplement #5. Emphasize manufacturer's specifications for procedure.	

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Additional Information to Modify Project Guide #2

The need for a very well described course was a result of the need to evaluate the student's ability to direct an aircraft in a confined area. If the course is fairly well defined, the student is not allowed a great deal of latitude in the method of controlling the aircraft. There are many ways that a course can be set up so that it is visible to all participants (white lines on the ground, cloth strips secured in a safe manner, or any other type of marking methods that do not pose a hazard to the people involved in the project.) The course dimensions can also be modified to fit within any area. The only consideration is that the course be set up so that it does not present a hazard to the people involved. For example, the course which is depicted in the training materials always keeps the aircraft director on the pilot's side of the aircraft. When the course has been successfully negotiated in one direction, have the directors or the next set of directors direct the aircraft's return over the course.

Some additional items which can make this project safer are:

1. Two-way radios for communication between the instructor and the aircraft operator
2. Bullhorn for communicating across the field (to be used by the ground handling supervisor)

It is advisable to practice the project with a person acting as the aircraft before using an aircraft with an operating engine.

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objective 10	Explain practices used in aircraft servicing procedures. Use Technical Information Supplement #4. Discuss the use of ground support equipment to accomplish aircraft servicing. Have students complete Workbook Supplement #6.	
Objective 11	Display in clear containers various types of aircraft fuels. Identify the fuels. Use Technical Supplement #4. Be sure to explain to students that if different fuel types are mixed in equal proportions, the fuel color will become clear. Have students complete EA-ITP-GW 7:7.	
Objective 12	Explain the fire hazards involved in aircraft fuels. Use Technical Information Supplement #4.	
Objective 13	List and explain the contaminants which commonly occur in aircraft fuels.	
Objective 14	Explain aircraft fuels, fueling, and defueling procedures. Use Transparency Master #12 and Technical Information Supplement #4. Have students complete Workbook Supplement #7.	
Objective 15	Explain safety practices used during fueling or defueling aircraft. Use Technical Information Supplement #4. Show film <u>Electrostatic Grounding.</u>	

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 16	Explain engine run-up procedures.		
Objective 17	Discuss Project Guide #3. Answer any student questions prior to performing the project guide. After completing the project guide, conduct a class discussion related to the project.		
Objective 18	Discuss Project Guide #4. Answer any questions prior to performing the project guide. After completing the project guide, conduct a class discussion related to the project.		

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TECHNICAL INFORMATION SUPPLEMENT #1--Terms and Definitions

- A. Flight line--Area of an airfield where airplanes are parked
(NOTE: This is also called a ramp.)
- B. Threshold of pain--Physiological point at which pain begins in the human body
- C. Foreign object damage (FOD)--Internal engine damage which occurs from injection of foreign objects into the engine gas path

Examples: Ground debris; birds or flying debris
- D. Thunderstorm--Usually a localized storm produced by a cumulonimbus cloud
(NOTE: A thunderstorm is always accompanied by lightning, thunder, and wind.)
- E. Windstorm--Storm characterized by high winds and little or no rain
- F. Spoiler--Device used to spoil lift by disrupting airflow over an aerodynamic surface
- G. Pitot tube--Open-ended tube that faces directly into the relative airstream of an aircraft and picks up ram (pitot) pressure to be used in an airspeed indicator
- H. Land plane--Airplane designed to operate from surface of land rather than water or snow
- I. Tiedown--Special anchoring provision on an airport surface by which airplanes may be secured when they are parked
- J. Seaplane--Airplane designed to land and take off from the surface of water
- K. Ski plane--Airplane whose wheels have been replaced with skis so it can be operated from snow or ice
- L. Helicopter--Form of heavier-than-air, rotor-wing aircraft whose lift is produced by engine-driven rotors, which are essentially long, narrow airfoils
- M. Spar--Main spanwise structural member of a wing or other airfoil

TECHNICAL INFORMATION SUPPLEMENT #1

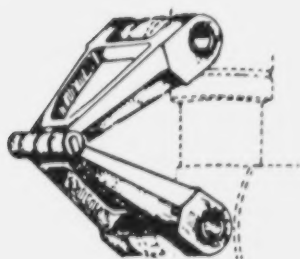
- N. Taxi--To move an airplane on the ground under its own power
- O. Oleo strut--Aircraft landing gear shock strut that absorbs initial landing impact by transferring oil from one chamber to another through a restricting orifice

(NOTE: Rough surface taxi-way shock is absorbed with compressed air or by a spring.)

- P. Torque links--Hinged linkage between piston and cylinder of an oleo shock strut; allows piston to move in and out, but restrains it from rotating (Figure 1)

(NOTE: These are also called scissors or nutcrackers.)

FIGURE 1



Reprinted from Aircraft Technical Dictionary, 2nd ed. Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

- Q. Auxiliary power unit (APU)--Power unit used to provide auxiliary air, hydraulic, and electrical power
- R. Volatility--Ease with which fluids change from a liquid to a vapor
- S. Static electricity--Electrical charge which may be built by friction upon a nonconductive surface
- T. Bonding wire--Wire or electrical connection used to ground a component or structure to an airframe
- U. Viscous--Thick; having high resistance to flow
- V. Biocidal action--Function of certain fuel additives which kill microbes and bacteria living in water in aircraft fuel tanks

(NOTE: This prevents scum which would promote corrosion in these tanks.)

TECHNICAL INFORMATION SUPPLEMENT #1

- W. Amphibian--Aircraft designed to take off and land from either land or water
- X. Scavenge--To remove an undesirable constituent from a substance or region by physical or chemical means
- Y. Hangar rash--Condition which occurs from an aircraft being ground handled in a rough and unprofessional manner

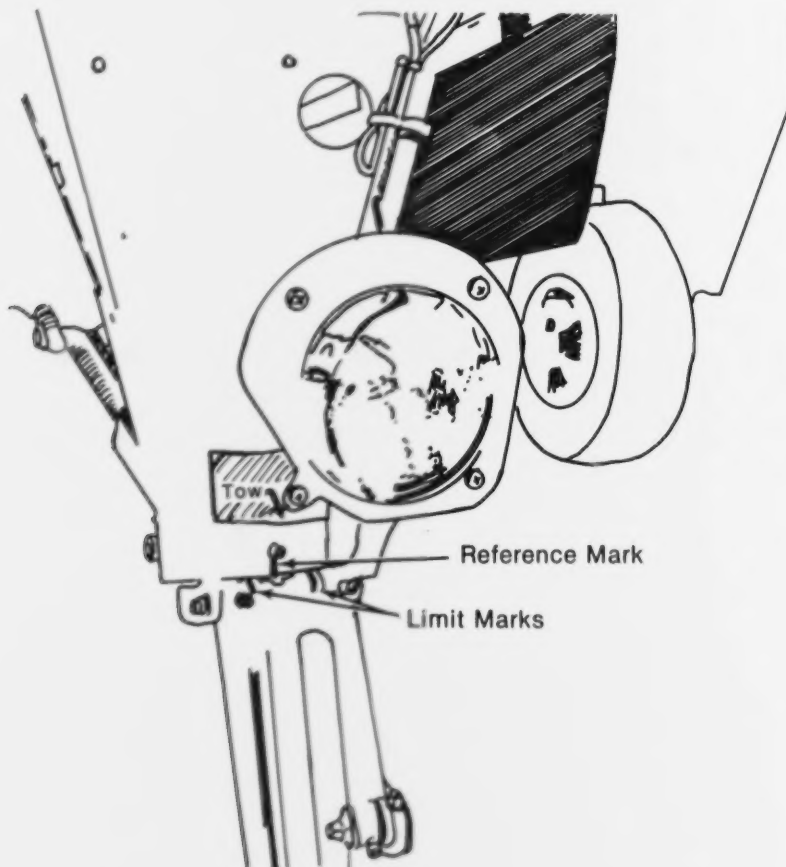
(NOTE: The aircraft's skin will become dented, scraped, and otherwise damaged.)

- Z. Tow limit marks--Marks on the aircraft's nose gear which show the maximum allowable travel off-center for the nose gear (Figure 2)

(NOTE: Any travel past three marks will result in damage to the nose gear.)

EXAMPLE:

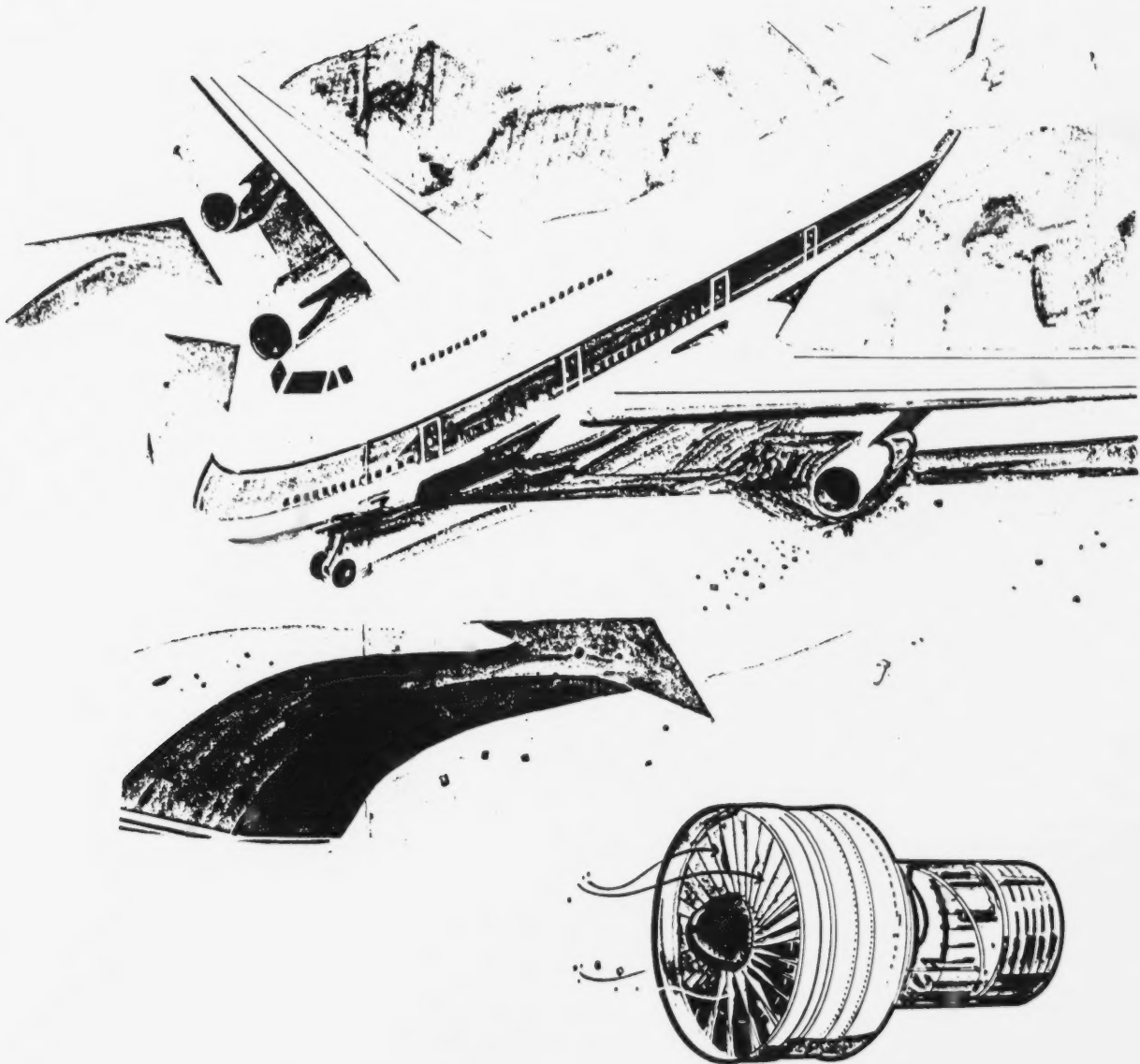
FIGURE 2



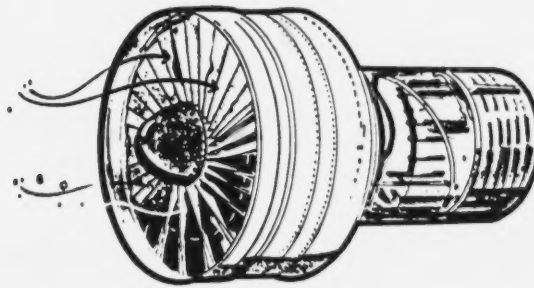
From the National Safety Council, 444 North Michigan Avenue, Chicago, Illinois 60611.

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TECHNICAL INFORMATION SUPPLEMENT #2--FOD, Propeller,
and Rotor-to-Person Safety



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Foreign Object Damage: **Trash It**

It's a dangerous, wasteful hazard that costs millions, but getting rid of FOD seems to be an almost impossible mission.

By JOHN F. O'NEILL

What can be as large as a horse, small as a grain of sand, is often ignored and last year cost the aviation industry over \$50,000,000? Give up? The "foreign objects" in foreign object damage, better known as FOD. Ask anyone associated with aviation what FOD is and you'll probably get a reply to the effect that it is the stuff that gets picked up and ingested into jet engines, causing damage of some type.

Contrary to the general opinion, FOD is not just a jet aircraft or engine problem. Turbine jets, turbo-props, reciprocating engine aircraft and rotorcraft are all subject to varying degrees of FOD. If it has an engine or a propeller, it is pretty much fair game for FOD. Even APUs have been the target of wandering foreign objects.

One of the classic prop-jet FOD stories occurred some years ago at what was then Allegheny Airlines. The inaugural flight of the Convair 540, (the Napier "Eland"-powered Convair 340/440), which initiated prop-jet service between Pittsburgh and Philadelphia, taxied away from the gate with a full load of VIPs when the left prop lifted an improperly secured

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fueling pit manhole cover, resulting in major damage to prop and engine. Total length of the inaugural "flight" was about 50 feet!

Damage to turbo-prop engines is not as common as it is in pure jet engines, as the inlets are generally smaller and the propeller serves as a good protection device. However, first stage impeller nicks and scratches are frequently encountered when small stones and debris are picked up from the runway during propeller reverse pitch operations after landing.

And there is an occasional instance where a bird makes it through the propeller and is ingested into the engine, resulting in a bent blade on the first stage impeller.

Rough on turbines

Turbo-fan engines are not nearly as forgiving as turbo-props, however. And while cases of in-flight engine ingestion are more plentiful, the most serious incidents generally occur on the ground.

According to Joe MacLeod of Garrett Customer Service Engineering, the most common in-flight FOD is caused by birds. Of the 100 separate instances of in-flight bird ingestion reported to Garrett, ranging from a single bird in one engine to several birds in more than one engine, there has been no case of the loss of an aircraft and only a few cases of serious engine damage. In twelve cases the pilot elected to return to the airport of departure, five of the events resulted in in-flight shut down of one engine and in the remaining eighty-three cases, the flight was continued to the normal destination.

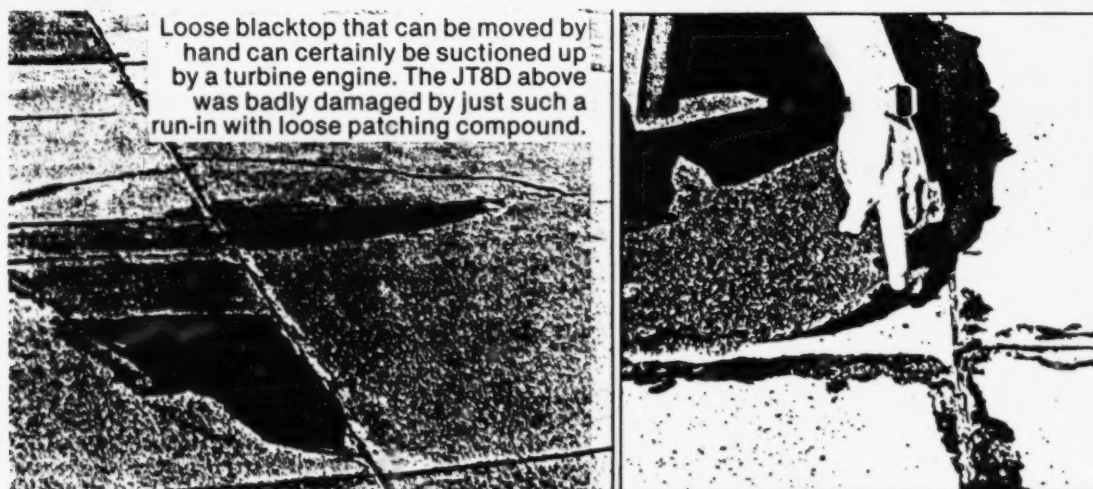
FIGURE 3



There is little that can be done to prevent in-flight FOD, but the ground environment is something else. The photos on page 21 show a collection of junk gathered at Baltimore Washington International Airport and displayed during an FOD seminar hosted recently by USAir. It's an interesting assortment of trash: part of a wheel rim, parts of a wire antenna, a padlock, fuel cap, spoon, the ever-present luggage tags and valet hang up hooks and, surprisingly, one of the supposed solutions to FOD - one of the brushes from a ramp sweeper came loose and became foreign object debris. Note finally the cotter pins and safety wire scraps.

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FIGURE 4



Foreign object debris comes from any number of sources, as the photographs indicate. But one often-overlooked area of potential FOD trouble is sometimes right underfoot: loose blacktop patching. Remember, if a man can lift it, so can an engine. The photo below shows an area where a large piece of blacktop has been lifted from the surface by jet suction and passed through a JT8D engine, with very damaging results.

Another of the most common sources of FOD is - ironically - dumpsters and trash containers placed on ramps or at gate areas with good intentions, but later allowed to fill to overflowing due to inadequate pick-up schedules.

One need not look far nor long to find frustrating FOD accidents waiting to happen. The ramp area at one airport was frequently strewn with gravel, particularly after high winds or heavy rains. The source? A poorly stabilized gravel roof on an adjacent building. Another report indicates that small stones and pieces of paving are more prevalent on operational surfaces after a hard downpour or a sustained rain. This is believed to be a result of water loosened stones from surface cracks and grass areas being forced to the surface where high winds or jet blast can blow them onto runways and taxi-ways.

A mechanic's uniform jacket was recently retrieved from an active runway, and investigation revealed he had placed it on the landing gear while working on the aircraft and forgot to remove it before the aircraft departed.

Human ingestion

While ingestion of wildlife running loose in airports is regrettable enough and avoidable if simple precautions such as fences are installed, the ingestion of human beings is far too commonplace and is inexcusable, considering that a few common sense precautions are all that's required to prevent it.

According to the Boeing Airliner Magazine, thirteen instances of human ingestion on the B-737 aircraft alone were recorded between 1979 and 1983.

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TECHNICAL INFORMATION SUPPLEMENT #2

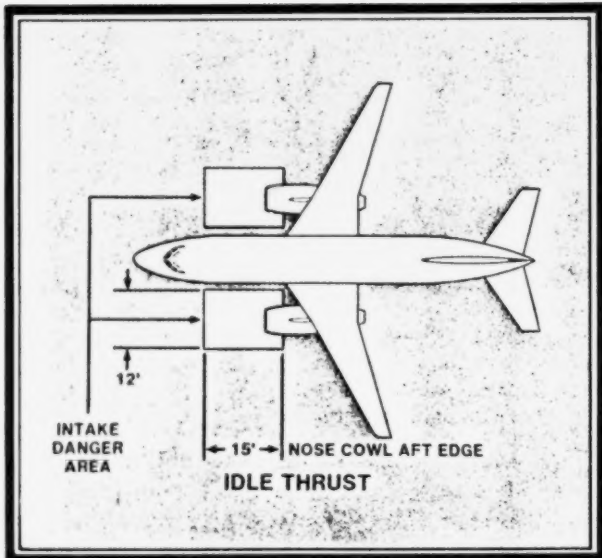


FIGURE 5 Note that the danger areas for wing-mounted engines include an area behind the intake.

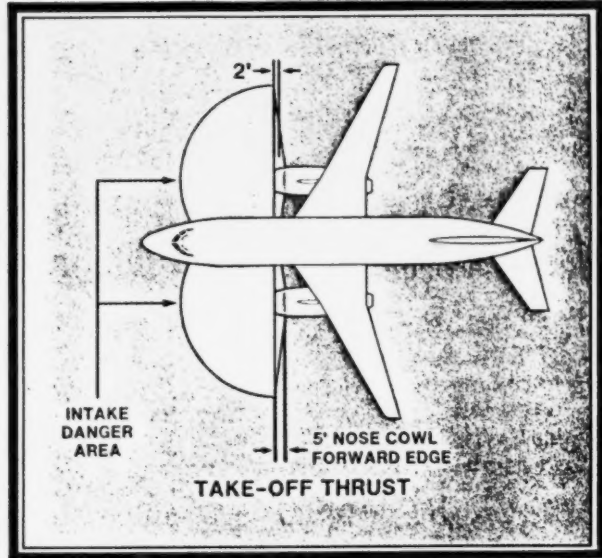


FIGURE 6 At take-off thrust, a B-737's engines will pull air laterally from wingtip to wingtip.

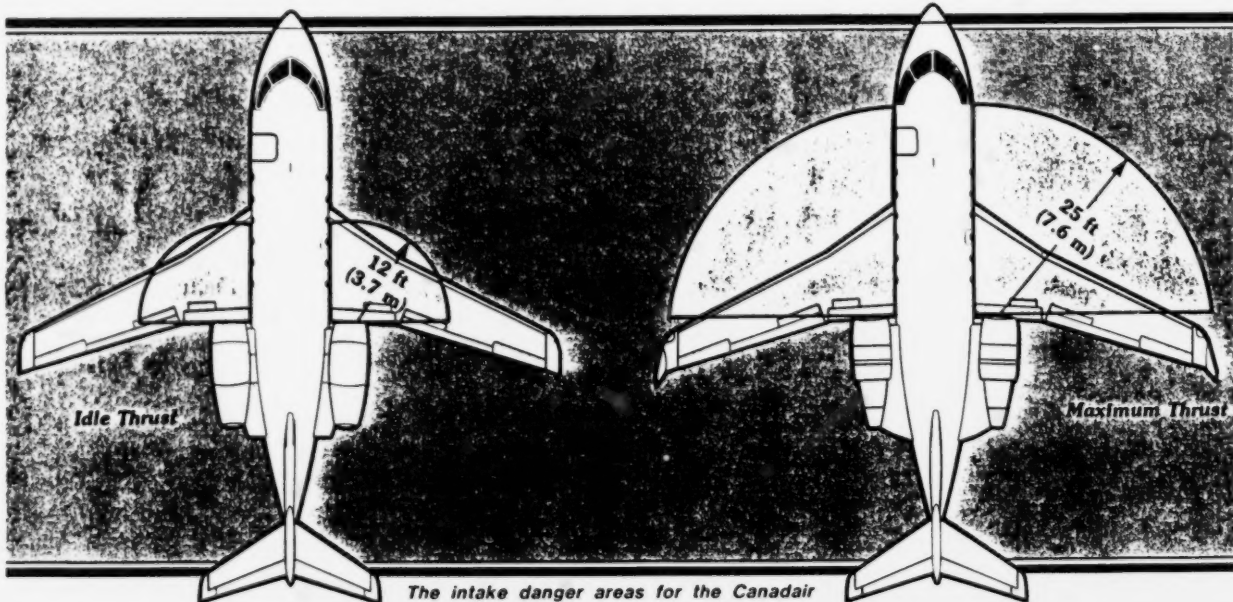


FIGURE 7 The intake danger areas for the Canadair Challenger are representative of those for most aircraft with fuselage-mounted engines.

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TECHNICAL INFORMATION SUPPLEMENT #2

Eight individuals were ingested while troubleshooting engine oil leaks, three while performing engine trim, one while adjusting engine oil pressure and one during refueling operations.

Garrett reports one incident in which a mechanic was sucked backwards into a TFE731 engine, but managed to hang on to the nacelle inlet. Fortunately, the engine had an elliptical spinner, rather than conical, allowing enough clearance for the mechanic to survive. While his coat was burned from the friction of the spinner on his back, he emerged from the incident frightened but physically unhurt.

The Douglas service Magazine for July/August 1980 recounts the story of an airline employee who ventured too close to the inlet of a running wing-mounted jet engine. According to the report, "The suction force of the engine pulled him toward the inlet. His hat and headphones were ingested, but, fortunately, he was able to save himself by hooking his elbow around the nose cowl lip."

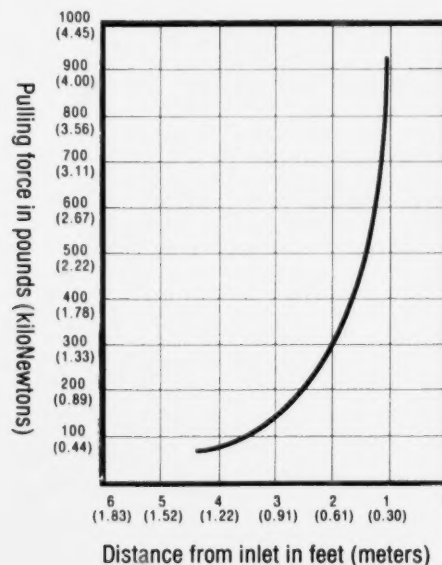
These near tragedies serve as a reminder that the suction forces of a jet engine constitute a potential danger to anyone who is present in the area of a running jet engine. Too frequently a lack of awareness or understanding of the invisible forces surrounding the engine inlet fosters complacency among ramp personnel who must work in the vicinity of engine inlets with engines running.

Suction

Figure 8 illustrates the strength of the pulling forces near the inlet of a wing-mounted engine operating at takeoff thrust. While the forces listed here are based on a DC-10 engine, forces of these magnitudes are typical of most wing-mounted engines.

FIGURE 8

*Pulling or Suction Force
as a Function of Distance*



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TECHNICAL INFORMATION SUPPLEMENT #2

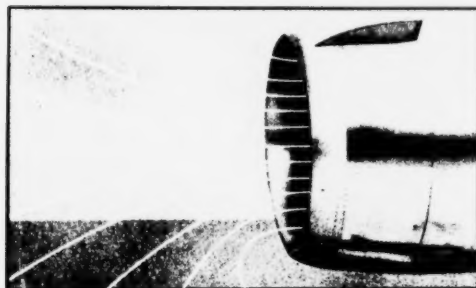
The pulling force felt by someone too close to a jet inlet is the same force felt in a strong wind - except that a wind of 25 mph exerts a force of only 20 pounds on an average size person. By comparison a force of about 1,000 pounds is exerted on a person standing about a step in front of a turbine engine operating at takeoff thrust. Even with the engine at idle, the pulling force is greater than 300 pounds.

When you consider that a person with nothing to hold on to can offer only about 95 pounds of resistance by skidding on the bottom of his shoes, you can see that the pulling force of an idling engine is sufficient to pull someone into the spinning compressor blades. It is certainly enough to pull in loose articles of clothing, rags and other loose objects from shirt or jacket pockets.

As Figure 8 illustrates, the pulling force increases rapidly as the distance between the inlet lip and the object acted upon decreases. Moving from a point three feet from the lip to half this distance raises the pulling force from about 150 pounds to 600 pounds, four times greater. Merely turning the body from profile to full face can double the forces, and standing up from a crouched position can triple the effects.

Not only do the pulling forces increase rapidly as an object moves toward the inlet, but air flow directions changed rapidly around the inlet and can cause a body passing through the different airflows to twist, tumble

FIGURE 9



and lose control (see Figure 9). In addition to these dangers, natural winds and uneven forces due to sudden gusts can extend the normal danger area by several orders of magnitude. Moreover, buildings, fences, the aircraft fuselage and wings can create highly localized wind forces and unpredictable shears that will add to the inlet induced flow field, requiring additional margins for safety.

Just because an engine is small or running at idle is no excuse for a casual attitude. Although the airflow of a smaller engine is less, the suction forces are just as powerful as those produced by larger engines, and even though engines are not usually run at high thrust in maintenance, ramp, or terminal areas, the throttles could be advanced without warning to ground personnel.

Never, never, never leave an auto throttle system activated while running an aircraft engine on the ground. Pull circuit breakers and install lock-out rings, or remove units or connectors and tag the area with red warning tags. There are all forms of potential interferences which can cause unintentional throttle advancement.

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Funny object damage?

While FOD is never funny - only expensive and frightening - some of the foreign object damage reports that turn up are rather bizarre and deserve repeating, since we can learn something from the humor involved. If it is moveable and hangs around an airport, chances are it's tried to go through an engine - with varying degrees of success. The numbers of flight bags, valet bags, flight manuals, ladders, work stands, tools, tool boxes, portable lights, power units and radio test sets are legion. However, some items are beyond expectation.

FIGURE 10

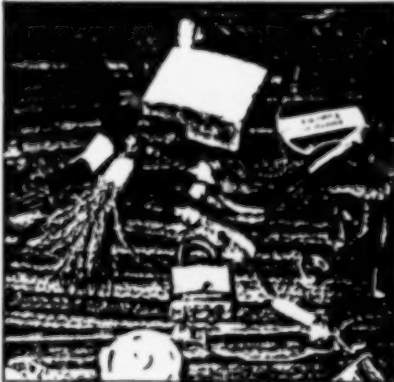


FIGURE 11



FIGURE 12



From the Philippines we hear of the abrupt termination of a canine romance when an aircraft struck and ingested the two somewhat distracted dogs.

From Argentina we have a report that, following a collision with a horse, the subject aircraft needed extensive work. The engine manufacturer's local representative filed his report, indicating that the engine had ingested parts of the animal and a "large quantity of preprocessed hay."

A turbo-prop aircraft tangles with a pheasant and the remains of this large bird passed through the propeller, both impellers and was jammed between the turbine plenum and the combustor, causing a flame-out. Nonetheless, the aircraft landed safely. The engine was removed and sent to the manufacturer for repair, but as such things will, it sat in its shipping container for a couple of weeks in 100°F weather. When the engine was removed from the container - whew - no one could get near enough to disassemble it until it had sat around for a couple of weeks airing out.

But...so much for the humorous side of the picture and back to the serious.

Get results

What can you do about FOD? The process of eliminating or reducing foreign object debris and damage starts with you, no matter what your job or title is. If you work at the airport, you can help. No matter where you are around the field, keep an eye out for junk on the ramp,

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TECHNICAL INFORMATION SUPPLEMENT #2

hangar floors and shops. Wherever it may be, if you see something, pull a deep knee bend and pick it up. It will be one less potential hazard.

Consider an FOD elimination program for your airport or facility. If your area is served by commercial air transport, talk to the local airline maintenance supervisors. Chances are they have a program to control their own FOD problems and would be glad to share their information with you, welcoming your assistance.

Talk to the airport operators or supervisors. "Schedule a walk around the ramps, taxiways and runways to point up the trash and potential safety hazards it represents. Call a session with other operators at your base and schedule a clean-up; then display the results at a seminar on FOD. When you see the stuff piled up on a table, you take the problem seriously. Call your local engine representatives or overhaul agencies. They are generally very cooperative and can often provide damaged parts, posters, films and video tapes for your seminar.

If your airport has a sweeper, vacuum and/or a magnetic pick-up device, see when and where it is scheduled, and if it is not frequent enough, discuss the problem with the airport management.

There are dozens of posters available from engine manufacturers. Display them prominently. Hold meetings to educate everyone in your company on the problems of FOD and how it hits them in the pocket as a result of increased operating costs. Perform cross checks of other areas with various tenants. It's surprising what the other guy can find and how hard he will look - and vice-versa.

FIGURE 13



Educational material, such as the items above generated by USAir, are often available from carriers and manufacturers.

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Commercial magnetic pick-up devices are relatively expensive, but I have seen a Jeep with a large, electro-magnet hung from the snow plow support - built by an A&P - that does an excellent job. The magnet was constructed of two three-foot diameter half-inch soft iron plates, with the coil wound from a couple of surplus power cords from a DC aircraft power unit and powered by a 100-amp aircraft generator, driven by the jeep engine. All surplus, but super effective for picking up ferrous material.

Another neat trick is to install magnets on the bottom of frequently used ramp vehicles. Check your local avionics shop for defunct magnetrons from older radars (have them take the tubes out), and you have one powerful pick-up device that works every time you cross the ramp.

When conducting runway and taxiway inspections, take along a can of fluorescent spray paint and outline any areas of bad sealant, spalled or cracked areas, and so on. This will alert flight crews and assist maintenance personnel in locating areas in need of repair.

Winter is a particularly troublesome time where FOD is concerned. If snow is forecast, ensure that the ramp areas are free of debris so it is not trapped or buried under snow. Ramp, taxiway and runway expansion strips that are loosened during the hot summer months may be pushed up and out when water collects underneath and expands when frozen.

Ramp vehicle chain maintenance is especially important. Broken chain links are a real threat to both engines and tires. Also, keep the ramp and taxiways free of ice chunks. Particularly, watch for ice accumulations that may have dropped from vehicles used on public highways and that may contain salt products. Corrosion and FOD ride hand-in-hand on these troublemakers. Remove them from the ramp and shovel up the snow where they fell. Get rid of salt carefully; don't just throw it on a snow bank, where it can run back onto the ramp as the snow thaws.

Sand is great for beaches, but bad news for engines, landing gear and control surfaces of aircraft. Sand used on airports should meet FAA recommended standards. Cheap sand can turn out very expensive in the long run.

As far as human ingestion is concerned, there is also a lot you can do. Talk up the problems. Every aircraft manufacturer publishes data outlining the dangerous and hazardous areas around engine inlets. Know these areas for all aircraft you normally handle or service. Make sure all personnel with ramp access also know and understand these hazards. If you have a normal run-up area, it is a good idea to paint wheel marks on the ramp and outline the engine hazard areas. Keep a sharp eye out when visitors or strangers are in the area or on the ramp.

In summary you can help eliminate FOD by:

- * Talking up the FOD problem.
- * Providing a flow of information on FOD.
- * Organizing an FOD program if none exists at your base.
- * Conducting training of all employees exposed to areas where FOD can exist or occur.
- * Setting an example. Be visible; pick it up yourself and get others started.
- * Holding employees and supervisors responsible for their areas.
- * Providing adequate receptacles for trash and debris and ensuring adequate pick-up.
- * Appointing a supervisor for daily check of ramp, hangar, maintenance areas and your local taxiways.

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TECHNICAL INFORMATION SUPPLEMENT #2

If you decide it is not your job, then chances are it won't get done. Sure, it takes time and time is money, but how much of last year's \$50,000,000 could have been eliminated if each of us had picked up just one piece of trash that eventually found its way into an engine?

Editor's note: Some of the material and photos used in this article were furnished through the courtesy of the Boeing Commercial Airplane Company, the McDonnell Douglas Corporation, Garrett General Aviation Services, USAir, Inc. and the Air Transport Association of America.

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Eastern's FOD Education and Awareness Efforts

When a major airline operates hundreds of aircraft in dozens of locations, foreign object damage can be a major problem, Eastern Airlines has developed a training and awareness program to keep the company's employees alert to potential FOD damage and encourage them to take preventive measures so that costly engine repairs can be avoided.

Bob Horn, Eastern's manager for ground safety based in Miami, Florida, sees his first task in helping to reduce FOD incidents as determining when and where the problem occurs, which is often more difficult than it may appear.

"One of the problems when you have foreign object ingestion discovered is that you really don't know where it was picked up," he said. "The aircraft can fly several flights with an FOD on board and (no one) realize it."

"As a result, we track the station that reported it and the three previous stations of landing, so we consider all four stations equally suspect as the source of that FOD.

"We then compare those (with) the number of landings and departures at that station and get a suspect rate per thousand departures. We can begin to track a station that shows a progressively higher suspect rate or consistently high suspect rate and are usually able to identify a problem at that station that they're unaware of."

With this information, Horn is able to provide Eastern's ramp and line personnel with a picture of what causes many of the FOD incidents. "We show them what the trends are" he said. "We have some handouts, some photographs of FOD sources and causes, and what the seasonal problems are and what we specifically look for in each season."

Eastern has had an active FOD program for 10 years and Horn reported that the airline has really started showing progress in controlling FOD since about 1979. "It's not a formalized course, we have some videotapes and booklets and other things," he said. "It's part of a normal station's training." These training sessions are carried out on location at airports all over Eastern's service area.

Seasonal FOD problems that Eastern has experienced in the warmer months can come from pieces of runway sealant stripping, or mowing operations. In the winter, buildup of ice, breaking up or spalling of concrete and asphalt, or the wearing and breaking off of vehicle tire chains may all produce objects that can be ingested by the engine.

Year round potential FOD incidents fall into two broad categories. "The most common FOD problem is trash generated by the carriers as we load or unload the aircraft," Horn said. "This can consist of little bag buttons off the bottom of the bags, little rollers, zipper tabs, name tags or small locks.

"Maintenance generated trash includes light bulbs, safety wire, nuts and bolts that are dropped, and items that come off the ground equipment."

Any of these objects can damage the aircraft. "The engine will swallow anything that happens to be there," Horn explained. "For many years, there was a strong feeling that the engine can't pick up that stuff off the ramp, but they can and they do."

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TECHNICAL INFORMATION SUPPLEMENT #2

Another element of Eastern's education and awareness effort involves airport personnel. "We ask that one of our people go out with the airport operator once a week at each airport and do a runway inspection and train them what to look for," Horn said. "We found many cases where the airport operators were running down the runway at 60-70 miles an hour and were not seeing the problem. It's been an education problem for them too.

"It's a constant battle to keep the ramps clean and keep everyone aware of the need to keep them clean," he emphasized. "If you see it, pick it up. Be very conscious and aware of your ramp cleanliness."

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U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: HAZARDS OF ROTATING PROPELLER
AND HELICOPTER ROTOR BLADES

Date: 3/3/83
Initiated by: AWS-340

AC No: 91-42D
Change:

1. PURPOSE. This advisory circular updates statistical information on propeller- and rotor-to-person accidents and offers suggestions to reduce the frequency of those accidents.
2. CANCELLATION. AC 91-42C, Hazards of Rotating Propeller and Helicopter Rotor Blades, dated May 22, 1981, is canceled.
3. BACKGROUND. A review of National Transportation Safety Board reports of propeller- and rotor-to-person accidents for the years 1979, 1980, and 1981, showed a total of 54. Of those accidents, two were the result of helicopter rotors which caused two serious injuries. The 52 propeller accidents caused 9 fatalities and 45 serious injuries. In two of the propeller accidents, two persons received serious injuries. Propeller- and rotor-to-person accidents are a small percentage of the total aircraft accidents. With proper education and discipline, those accidents could be reduced to zero. The following chart summarizes the events leading to the various accidents.

EVENTS LEADING TO THE ACCIDENT	FATALITIES	SERIOUS INJURIES
Passengers deplaning aircraft with operating engine(s)	2	16
Passengers enplaning aircraft with operating engine(s)	1	3
Handcranking of propellers by pilot	1	9
Handcranking of propeller by passengers	0	2
Pilot working on aircraft with engine(s) operating	0	2
Passengers assisting pilot taxiing and parking	2	1
Bystanders in vicinity of operating aircraft	2	7
Ground personnel working near aircraft with operating engine(s)	1	2
Propeller blade separation	0	0
Ground personnel working near helicopters with rotor in motion	0	2
Handcranking of propellers by ground crew	0	2
Pilot exiting aircraft with engine operating	0	1

4. GENERAL. It is particularly tragic that propeller- and rotor-to-person accidents, along with airmen, have included bystanders, passengers, and children among the injured persons. Propeller- and rotor-to-person accidents differ from other aircraft accidents in that they usually result in fatal or serious injury. This is due to the fact that a propeller or rotor rotating under power, even at slow idling speed, has sufficient force to inflict serious injury. It should be remembered that a rotating propeller or rotor is extremely dangerous and should be treated with all due caution.

5. CONSPICUITY. The propeller or rotor is difficult to see when in operation, and the nonprofessional public is often not aware of its danger. Even personnel familiar with the danger of a turning propeller or rotor are likely to forget it.

a. Some manufacturers of propeller and rotor blades use paint schemes to increase the conspicuity of the blades. Owners should give strong consideration to maintaining the conspicuity paint scheme of the original manufacturer.

b. In the event that the paint scheme does not lend itself to conspicuity, the owner should consider having the blade repainted. A customized paint scheme should not be used until an evaluation is made by a person qualified to determine that it will not interfere with the pilot's visibility, promote vertigo, or create an unbalanced blade condition.

c. In August of 1978, the FAA issued Report No. FAA-AM-78-29, Conspicuity Assessment of Selected Propeller and Tail Rotor Paint Schemes. The report summarizes the evaluation of three paint schemes for airplane propellers and two for helicopter tail rotor blades. The document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

6. NONFLIGHT CREW PERSONNEL. Persons directly involved with emplaning or deplaning passengers and aircraft servicing should be instructed as to their specific duties through proper training, with emphasis placed on the dangers of rotating propellers and rotors. Ramp attendants and passenger-handling personnel should be made aware of the proper procedures and methods of directing passengers to and from parked aircraft. The following safety measures should be considered to help prevent accidents on airport ramp areas:

a. When the possibility of passengers wandering on the ramp exists, physical barriers should be provided such as rope stanchions from the aircraft to the terminal doors.

b. Airport management personnel should be on the alert to keep unauthorized persons from milling around on ramps among parked aircraft. When spectators are permitted to view and move among aircraft parked on a ramp, the airport management personnel should caution those persons to stay clear of all propellers and not touch or move them.

TECHNICAL INFORMATION SUPPLEMENT #2

c. Helicopter landing and ramp areas should be marked and provided with safety barriers to restrict access by unauthorized persons.

d. Tail rotor danger areas should be clearly marked on ramp areas. Helicopters should be parked with tail rotors within the marked area.

7. AIRCRAFT SERVICE PERSONNEL. Persons directly involved with aircraft service are most vulnerable to injuries by propellers or rotors. Working around aircraft places them in the most likely position for possible propeller or rotor accidents. Aircraft service personnel should develop the following safety habits:

a. Treat all propellers as though the ignition switches are "on."

b. Chock airplane wheels before working around aircraft.

c. Use wheel chocks and parking brakes before starting engines or handcranking engines. Handcranking a starter-equipped engine with a low battery or defective starter, although convenient, can expose personnel to a possible accident. For safety reasons, the replacement of the faulty starter and the use of a ground power source should be considered rather than handcranking. Only experienced persons should do the handcranking with a reliable person in the cockpit. Handcranking with the cockpit unoccupied has resulted in accidents.

d. Attach pull ropes to pull chocks from wheels close to rotating propeller or rotor blades.

e. After an engine run and before the engine is shut down, perform an ignition switch test to detect a faulty ignition switch. Follow the manufacturer's recommendations for the switch test and the procedures to be followed when a faulty switch is found. Applicable airworthiness directive requirements related to ignition switches have been issued to help locate and eliminate faulty switches.

f. Before moving a propeller or connecting an external power source to an aircraft, be sure that the aircraft is chocked, ignition switches are in the "off" position, throttle is closed, mixture is in "idle cut-off" position, and all equipment and personnel are clear of the propeller or rotor. Faulty diodes in aircraft electrical systems have caused starters to engage when external power was applied regardless of the switch position.

g. Remember when removing an external power source from an aircraft, keep the equipment and yourself clear of the propeller or rotor.

h. Always stand clear of rotor and propeller blade paths, especially when moving the propeller. Particular caution should be practiced around warm engines.

i. Ground personnel should be given recurrent propeller and rotor safety lectures to keep them alert to dangers when working around helicopters and fixed-wing aircraft.

TECHNICAL INFORMATION SUPPLEMENT #2

j. Before removing chocks, signal pilot to hold brakes or apply parking brake.

k. Be sure all equipment and personnel are clear of an aircraft before giving the pilot the signal to depart.

8. FLIGHT PERSONNEL AND FLIGHT INSTRUCTORS. Prior to starting an engine, flight personnel should make certain that all personnel are clear of the propeller or rotor.

a. The engine of a fixed-wing aircraft or of a helicopter should be shut down before boarding or deplaning passengers. This is the simplest method of avoiding accidents.

b. Boarding or deplaning of passengers, with an engine running, should only be allowed under close supervision. The pilot in command should have knowledge that either the company or the airport operator has ground attendants fully trained in their specific duties to board or deplane passengers from an aircraft with an engine(s) running. The pilot should instruct passengers, before they exit an aircraft with an engine(s) running, the path to follow to avoid the propeller or rotor blades.

c. When it is necessary to discharge a passenger from an aircraft on which an engine is running, never stop the aircraft with the propeller in the path of the passenger's route from the aircraft.

d. When flight and ground instructors are instructing their students about propellers or rotors, they should emphasize the dangers of rotating propeller and rotor blades. Students should be taught the techniques and safety procedures for handcranking, and how to determine which engines should not be handcranked. Safety through education is the best and most positive means available for reducing potential accidents from rotating propeller and rotor blades.

e. The prestart portion of the checklist should include an item to make sure the propeller or rotor blades are clear. The proper use of the aircraft checklist should be taught to all student pilots.

f. Flight personnel should perform an ignition switch test prior to engine shutdown to detect faulty switches. (See item 7e.) The checklist should include an item for that test to be made and an item to assure that the switch is off before leaving the cockpit.

9. SUMMARY.

a. In reviewing propeller- and rotor-to-person accidents, the most impressive fact is that every one of them was preventable. The danger of rotating propeller or rotor blades is universally recognized.

b. The pilot can be most effective in ensuring that his or her passengers arrive and depart the vicinity of the airplane safely by stopping the engine completely at the time of loading and unloading, or by providing a definite means of keeping them clear of the propeller if it is left in motion.

3/3/83

AC 91-42D

TECHNICAL INFORMATION SUPPLEMENT #2

c. Prominent warning signs, placed in the aircraft's interior near or on the inside face of the aircraft doors to alert passengers and crewmembers of propeller or rotor hazards, could be helpful in preventing accidents.



M. C. Beard
Director of Airworthiness

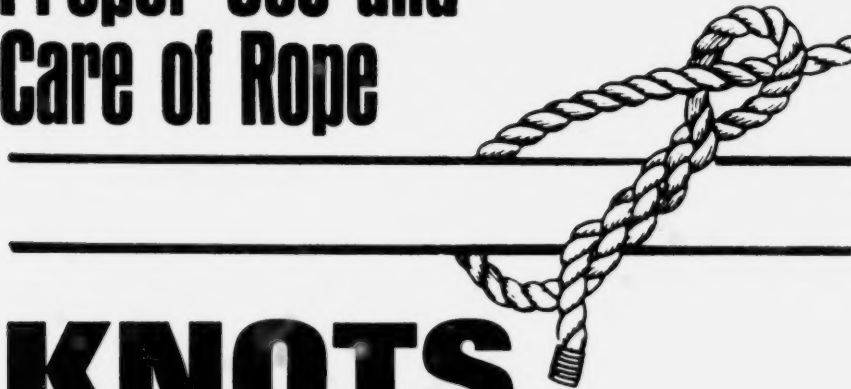
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5

TECHNICAL INFORMATION SUPPLEMENT #3--Proper Use and Care of Rope

Proper Use and Care of Rope



KNOTS HITCHES & SPLICES

WORKING LOADS are for rope in good condition, free of cut fibers, or damage in any way, and being used in non-critical applications under normal service conditions. **WORKING LOADS** should be reduced where life, limb or valuable property are involved, or for exceptional service conditions such as shock loads. **WORKING LOADS** should not be exceeded or used in critical applications without consulting the manufacturer.

TENSILE STRENGTH applies to new, unused rope. **WORKING LOADS** are from 8% to 14% of the tensile strength.

Used with permission of LeHigh Cordage, Allentown, Pennsylvania 18105.

To prevent twisted rope from unraveling when cut...

1. **NYLON, POLYESTER and POLYPROPYLENE:** Tape the rope around circumference as illustrated. Cut in middle leaving tape intact on either side. When cutting these synthetic fibers with a pocket knife or scissors, the cut ends should be fused by match-flame to prevent untwisting.

FIGURE 14



Tape is unnecessary if a "hot knife" is used. Heat will melt and fuse the cut ends.

2. **MANILA and SISAL:** Tape the rope as illustrated above. Cut in middle so that each end remains permanently taped. Natural fibers do not fuse with heat.

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Figure Eight Knot: Can be tied simply and quickly. Used in the end of a rope to temporarily prevent the strands from unlaying. Does not jam as easily as the overhand knot and is therefore useful to prevent the end of a rope slipping through a block or an eye.

FIGURE 15



FIGURE 16



Reef Knot: Probably the most useful and popular of all knots, also known as the Square Knot. Used to join two ropes or lines of the same size. Holds firmly and is easily untied.

FIGURE 17

Surgeon's Knot: Usually tied with twine. This is a modified form of the Reef Knot and the extra turn taken in the first tie prevents slipping before knot is completed.

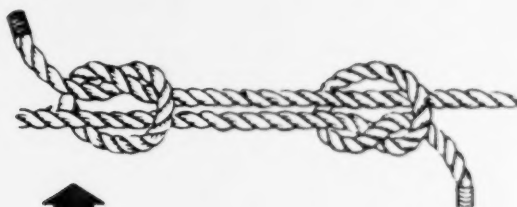
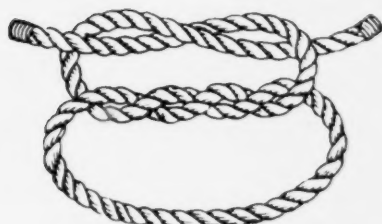


FIGURE 18

Fisherman's Knot: Probably the strongest known method of joining fine lines such as fishing lines. Simple to tie and untie.

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FIGURE 19

Fisherman's Bend: An important knot because of its strength and simplicity. Used for making the end of a rope fast to a ring, spar or anchor, or for bending a line to a bucket. It is easily cast adrift, even after being subject to severe strain. More secure when the end is seized as shown.



FIGURE 20

Bowline: A favorite knot with sailors and one of the best known and widely used of all knots. It is easily constructed and used whenever a loop is required that will not slip, jam or fail.

Timber Hitch: Very useful for hoisting spars, boards or logs. Also handy for making a towline fast to a wet spar or timber. Holds without slipping and does not jam.

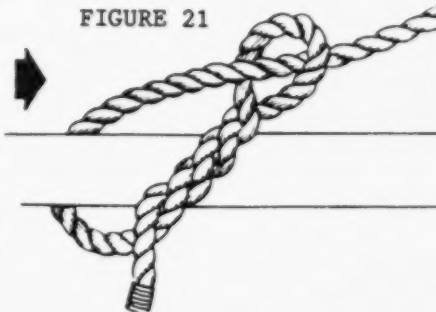


FIGURE 21

FIGURE 22

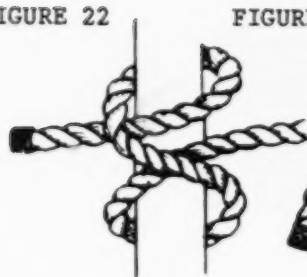
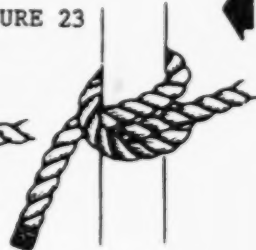


FIGURE 23



Clove Hitch: Also known as Builder's Hitch because of its wide use by builders in fastening staging to upright posts. Another common use is for making a line fast to a wet spar.

Sheet Bend (Weaver's Knot):
Regularly used aboard ship
for joining small or medium
sized ropes. Sometimes used
for attaching the end of a
rope to an eye splice. Pop-
ular in textile mills for join-
ing threads or yarns.

FIGURE 24



The **EYE** or **SIDE SPLICED**

The Side Splice is also called the Eye Splice because it is used to form an eye or loop in the end of a rope by splicing the end back into its own side. This splice is made like the Short Splice except that only one rope is used.

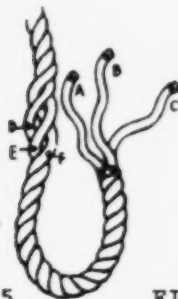


FIGURE 25



FIGURE 26



FIGURE 27

1. Start by seizing the working end of the rope. Unlay the three strands, A, B and C, to the seizing and whip the end of each strand. Then twist the rope slightly to open up strands D, E and F of the standing part of the rope, as indicated in Fig. 25.

2. The first tuck is shown in Fig. 26. The middle strand is always tucked first, so Strana B is tucked under Strand E, the middle strand of the standing part.

3. The second tuck is now made, as shown in Fig. 27. Left Strand A of the working end is tucked under Strand D, passing over Strand E.

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FIGURE 28



FIGURE 29



FIGURE 30



FIGURE 31



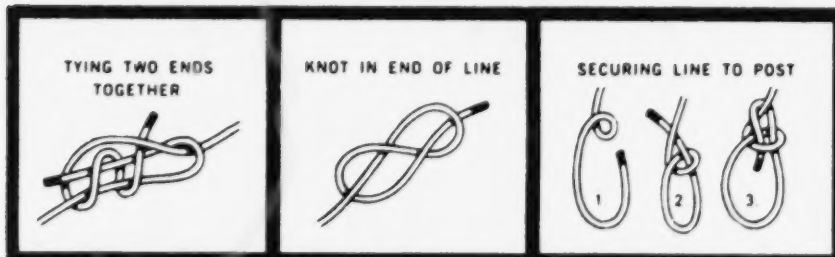
4. Fig. 28 shows how the third tuck is made. In order to make Strand F easy to get at, the rope is turned over. Strand C now appears on the left side.

5. Strand C is then passed to the right of and tucked under Strand F, as shown in Fig. 29. This completes the first round of tucks.

6. Fig. 30 shows the second round of tucks started, with the rope reversed again for ease in handling. Strand B is passed over Strand D and tucked under the next strand to the left. Continue with strands A and C, tucking over one strand and then under one to the left. To complete the splice, tuck each strand once more.

7. The finished Eye Splice is shown in Fig. 31. Remove the temporary seizing and cut off the strand ends, leaving at least $\frac{1}{2}$ " on each end. Roll the splice back and forth under your foot to even up and smooth out the strands.

RECOMMENDED KNOTS FOR TYING POLYPROPYLENE CORD.



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GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

TECHNICAL INFORMATION SUPPLEMENT #4 - AIRCRAFT FUELING

Millions of gallons of fuel and a considerable tonnage of oxygen are serviced each year into general aviation aircraft. Both are usually handled safely because their hazards are recognized and necessary precautions are taken. Understanding of their characteristics is important as a basis for establishing procedures to prevent fires, injuries to employees and the public, aircraft damage and possibly inflight engine trouble.

Fuel and oxygen services are incompatible and must never be attempted simultaneously.

Fuels

Three essential requirements must be satisfied before a liquid fuel can be burned:

1. The fuel must be converted to a vapor.
2. The fuel vapor must be mixed in proper proportion with air (fuel-air ratio).
3. A source of ignition must be present.

See Chapter 9, "Fire Protection," for a fuller discussion of how fuels burn.

Definitions

A number of terms are used to refer to the properties of liquid fuels. The major terms are:

Volatility. The tendency of a liquid to evaporate or change to the vapor state.

Flashpoint. The temperature at which a fuel first gives off enough flammable vapor to be ignited. Ordinarily, the higher the vapor pressure (volatility) of a fuel, the lower its flashpoint.

Flammability limits. The vapor pressure of a fuel increases with the temperature of the fuel. Between two temperature extremes for each fuel, sufficient vapor will be present to form a combustible fuel/air mixture. The lower flammability limit is the leanest fuel/air mixture that will burn. The upper flammability limit is the richest that will burn. The area between is called the flammability range.

From General Aviation Ground Operations Safety Handbook, National Safety Council.

Liquid turbulence. Agitation that occurs during the filling of a tank increases the rate of evaporation and the release of vapors from fuel. Because of this turbulence, the flammability range will extend to a lower temperature and the combustion hazard is increased.

Fuel misting. Misting, or atomization, also increases the rate of evaporation and lowers the flammability range. Although temperature may be low, the likelihood of a combustible fuel/air ratio is greatly enhanced in this fine fuel spray. For example, the presence of a pinhole in a fuel hose will cause misting and an extreme fire hazard during fueling.

Ignition sources

Static electricity. Because the discharge of static sparks is a constant threat to safe fueling, proper grounding and bonding is essential. When two dissimilar materials like fuel and hose make physical contact and are then separated, a charge of static electricity is nearly always produced; for example, static electricity is generated when fuel is pumped through hoses and lines, the amount increasing linearly with the rate of flow. Obviously, underwing fueling of large aircraft, at high rates and pressures, will generate relatively more static electricity than would ordinary gravity fueling.

Static also occurs when fuel free-falls from a spout into a tank or container; charges even accumulate on airframes during flight or on the ground caused by wind and more profoundly by rain, snow, ice crystals, or dust moving across the surfaces. It can also be induced into airframes or fueling vehicles by an electrically charged atmosphere, such as that associated with thunderstorms. Static generates most readily in cold, dry atmospheres; the reader no doubt will recall the static shock he receives after walking across a carpet and then touching something, especially in the wintertime.

Static electricity flows like water along the easiest path to points of lower potential. If no easy path is provided, a charge builds up to a potential large enough to discharge as a spark to other conductive material nearby. If two objects are bonded by a conductive path to each other, current flows until their potentials are equal. The likelihood of sparking between them is eliminated.

Although bonding will eliminate a difference in potential between the objects that are bonded, it will not eliminate a difference in potential between these objects and the earth unless one of the objects possesses an adequate conductive path to earth. Therefore, bonding will not eliminate the static charge, but will equalize the potential between the objects bonded so that a spark will not occur between them.

An adequate ground will always discharge a charged conductive body continuously and is recommended as a safety measure whenever any doubt exists concerning a situation or a governing authority requires it.

To avoid a spark from discharge of static electricity during flammable liquid filling operations, a wire bond should be provided between the storage container and the container being filled, unless a metallic path between the container is otherwise present, such as a bonding wire built into the transfer hose. How-to-do-it steps are given later on in this chapter.

TECHNICAL INFORMATION SUPPLEMENT #4

Smoking. Matches, cigarette lighters, and other spark-producing materials should not be carried by any employees engaged in the fueling operation. The "no smoking" rule should be rigidly enforced. Because fuel vapors may settle and travel long distances along the ground, they can create a hazard away from the fuel source. If passengers remain aboard during fueling operations, there should be a qualified attendant in the cabin to enforce the no smoking rule, and to direct evacuation if this should become necessary.

Excessive fuel odors. Fueling should be stopped until any odor problem is corrected. Passenger loading steps should remain in position during fueling, and an unobstructed exit-way should be maintained for those on board to use in the event of emergencies.

Open flames. No open flames, smoking, backfiring mobile equipment, portable heaters, or other ignition sources should be permitted within 50 ft (15 m) of an aircraft that is being fueled. There should be no fueling while the aircraft engine(s) or aircraft auxiliary power unit is running. This includes wing and tail de-icing heaters.

Sparks. Electrical circuits may arc when connections are made. The following precautions are recommended to prevent arcing during fueling operations:

- *Do not install or remove batteries.
- *Do not connect, disconnect, or operate battery chargers.
- *Locate ground power units as far from fueling points as practicable. Do not connect or disconnect them during fueling.
- *Aircraft electrical switches that control units in wing or tank areas and that are not necessary to the fueling operation should not be operated.
- *Aircraft radios and radar should be off.
- *Do not fuel within 100 ft (30 m) of energized airborne radar or within 300 ft (90 m) of energized ground radar installations.
- *Photo flashbulbs should not be used in the immediate vicinity.
- *Flashlights that are used should be Underwriters Laboratories-approved for use in or near flammable atmospheres.

From General Aviation Ground Operations Safety Handbook, National Safety Council.

TECHNICAL INFORMATION SUPPLEMENT #4

Summary Data on the Fire Hazard Properties of Aviation Fuels

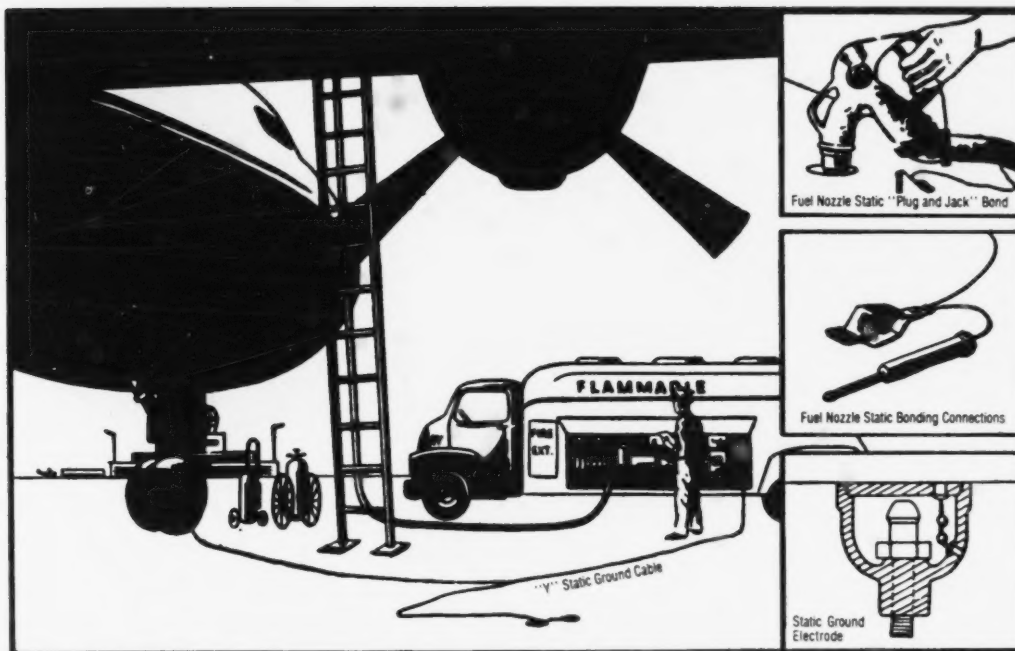
Characteristics	Gasoline	Kerosene Grades		Blends of Gasoline and Kerosene
	AVGAS	JET A JP-5, JP-6	JET A-1 JP-8	JET B and JP-4
Freeze Point	-76 F	-40 F	-58 F	-60 F
Vapor Pressure (Reid-ASTM D323-58)	5.5 to 7.0 lb/sq in.	0.1 lb/sq in.		2.0 to 3.0 lb/sq in.
Flashpoint (By closed- cup method at sea level)	-50 F	+95 F to + 145 F		-10 F to + 30 F
Flashpoint (By air saturation method)	-75 F to -85 F	None		-60 F
Flammability Limits				
Lower limit	1.4%	0.74%		1.16%
Upper limit	7.6%	5.32%		7.63%
Temp. Range for Flam- mable Mixtures	-50 F to + 30 F	+95 F to + 165 F		-10 F to + 100 F
Autoignition Temperature	+825 F to +960F	+440 F to +475 F		+470 F to +480 F
Boiling Points				
Initial	110 F	325 F		135 F
End	325 F	450 F		485 F
Pool Rate of Flame Spread*	700-800 ft per min	100 ft per min or less		700-800 ft per min

*In mist form, rate of flame spread in all fuels is very rapid

NOTE: Figures vary for some of these values in different data sources.
Those shown herein are average figures based on the latest available
information.

From National Fire Protection Association, Fire Protection Handbook, 15th ed.

FIGURE 32



Typical over-the-wing fuel servicing operation for an aircraft fuel-servicing tank vehicle uses this static grounding and bonding setup.

From NFPA 407, Aircraft Fuel Servicing, copyright 1980, National Fire Protection Association.

Grades of fuel and their use

Except for the table, the content of this section was taken from Federal Aviation Administration pamphlet "All About Fuels"; see references.

The Federal Aviation Administration (FAA) specifies the minimum grade of fuel that is acceptable for use in the aircraft specifications or aircraft-type certificate data sheet, which is issued by the aircraft manufacturer with the issuance of the aircraft-type certificate. The minimum grade of avgas to be used in aircraft engines is determined through extensive block testing by the engine manufacturers during the certification process and is stated on the engine specifications or type certificate data sheet.

Colors of fuel grades and types are shown:

Aviation gasoline 80	Red
Aviation gasoline 100	Green
Aviation gasoline 100LL	Blue
Jet A	Colorless or Straw
Jet A-1	Colorless or Straw
Jet B	Colorless or Straw

Fuels should be clean, bright, and colored as appropriate. If cloudy, or "off-color," suspect contamination and do not fuel the aircraft until all doubt is removed.

Never use automotive gasoline in aircraft engines because of the wide differences in compounding and production control of the two types of fuel. The additives used in the production of automotive gasoline vary widely throughout the petroleum industry and may have deteriorating effects on aircraft fuel system components. The qualities of automotive fuel can induce vapor lock, increase the probability of carburetor icing, and cause internal engine problems from detonation.

Placards-type of fuel. Be sure you use the type of fuel that is specified. Federal regulations require that all aircraft filler openings must be marked with the word "fuel" and the minimum fuel grade for reciprocating-powered aircraft, or the permissible fuel designation for turbine-powered aircraft. Even these requirements do not rule out the possibility of using the wrong type of fuel. Service personnel should be particularly cautious when facilities provide turbine fuel as well as avgas. Turbine or jet fuel is detrimental to the reciprocating engine and extended use of avgas can damage turbine engines. Therefore, it is imperative for service crews to doublecheck when fueling aircraft to make sure that they provide the proper type and grade of fuel. Although this responsibility is placed

From General Aviation Ground Operations Safety Handbook, National Safety Council.

upon the pilot of the aircraft by regulation, it just makes good sense for the ground crew to be sure. The fuel system sumps should always be drained and checked for contaminants after each fueling of the aircraft.

Avgas fuel additives. The FAA and several engine manufacturers have approved the use of certain carburetor anti-icing fuel additives in aviation gasoline. However, such additives should not be used without consulting the airframe manufacturer because their chemical content may not be compatible with the aircraft fuel system cells, seals, etc.

The same is true with lead-scavenging additives such as tricresyl phosphate (TCP). TCP, for example, has been used successfully to reduce lead fouling of spark plugs in normally aspirated reciprocating engines for several years. However, TCP should not be used in turbo-charged or super-charged engines without approval of the airframe manufacturer. TCP must be mixed according to the instructions provided by the manufacturer, Alcor Inc., for maximum effectiveness.

Turbine fuel. Occasionally, aircraft are inadvertently serviced with the wrong type of fuel and in most instances it is because of misleading signs. For example, certain turbo-supercharged reciprocating powered aircraft have paint designs with TURBO conspicuously displayed on the vertical stabilizer or on the engine nacelle. Line service personnel must not assume this to mean turbo-jet and fill the tanks with jet fuel. Another example involves an air carrier type aircraft that was originally equipped with reciprocating engines, which most operators converted to turbo-props. The service personnel assumed the aircraft was a converted model when it wasn't. Be sure to check carefully what fuel to use.

Reciprocating engines may run briefly on jet fuel, but detonation and overheating will soon cause power failure. So, beware of getting jet fuel when you need avgas. Avgas is no substitute for jet fuel either. The engine failure caused by running the turbine engine on the wrong fuel may not be as sudden, but prolonged operation on gasoline will severely damage the engine by the lead content and differing combustion ranges of the fuel.

Aircraft fueling procedures

First and most important - determine the correct fuel to be serviced and quantity desired from the flight crew. It is imperative that fueling personnel be able to identify the many varieties of general aviation aircraft and whether they require aviation gasoline or jet fuel. Several varieties of light twin engine aircraft resemble turbine-powered models to the untrained eye. The importance of this distinction cannot be overstressed as servicing improper fuel could be catastrophic to the pilot and passengers.

From General Aviation Ground Operations Safety Handbook, National Safety Council.

Gloves and goggles will protect line personnel from fuel splashes. Shoes or boots with metal nails or cleats must be prohibited because these create sparks when they contact other metal or concrete. (They also can damage wing surfaces and aircraft interiors.) Fueling personnel should not carry objects in the breast pockets of their clothing because such objects may fall out, creating sparks upon impact, or may even fall into the fuel tank. Matches and lighters should not be carried.

No vehicles other than those performing aircraft servicing functions should be permitted within 50 ft (15 m) of the aircraft during fueling. Line personnel must be aware of other operating aircraft nearby and discontinue fueling if, in their best judgment, a hazard exists. Such operating engines are hot and can represent an ignition source in the case of fuel spills and errant vapors, especially on hot, still days.

Fuel trucks should be driven to the aircraft in low gear and parked so they can be driven away in forward gear. It should never be necessary to operate fuel trucks in reverse gear in close proximity to aircraft.

When fueling overwing, use a mat to protect the wing surface and de-icer boots. If it is raining, effort should be made to cover the opening to prevent water from entering.

In underwing refueling, make sure the bayonet or toggle connections are clean, in good repair, and provide a fuel-tight seal. Take care to maintain flow pressure not greater than the maximum allowable for the aircraft being serviced.

Grounding and bonding. All aircraft refueling whether from fuel trucks, hydrants, cabinets, or island pumps, or over or under wing, should be grounded and bonded as follows:

1. An uninsulated grounding cable should be connected from the fuel service facility to a satisfactory ground.
2. Next, an uninsulated grounding cable should be connected from the aircraft to a satisfactory ground. The point of cable attachment to the aircraft should be a structural unpainted airframe member to assure electrical continuity. (The connection could be electrically insulated from the airframe if it were made to the landing gear below the shock struts and lubricated fittings.) The propeller blade and radio antenna must never be used.
3. An uninsulated bonding cable should be connected from the fuel-servicing facility to the aircraft.
4. Where possible, connect a bonding cable from the fuel nozzle to the aircraft before removing the aircraft fuel tank cap. If a cable is not available, make solid contact of nozzle with edge of the tank opening before removing the cap. Maintain this positive contact throughout the fueling process.

From General Aviation Ground Operations Safety Handbook, National Safety Council.

TECHNICAL INFORMATION SUPPLEMENT #4

The easiest way to accomplish these steps is by use of a "V" cable from the fuel-service facility to the ground and then to the aircraft.

After refueling, disconnect cables in reverse order.

If fueling in areas where satisfactory grounding is not possible, use extra care to assure positive bonding between the aircraft and the service equipment.

Fuel transfer

When transferring fuel, never block or wedge open the control and leave the fuel to flow unattended. Such unprofessional procedure can result in major fuel spills and fire.

Replace fuel and oil tank caps securely when servicing is completed. Never drape fuel hoses over wing surfaces because scratches and dents may result. Use stepladders to gain access to high wing fuel accesses. Never stand on the wing or wing struts instead of using a stepladder.

Fueling and defueling must never be conducted within hangars because of possible vapor accumulation. Fueling should never be attempted while aircraft engines are running.

Fueling from drums or cans. Overwing fueling from drums or cans requires proper grounding and bonding connections as in other fuel methods. Drums should be placed near grounding posts to facilitate this. Before containers are opened, connect the container to the ground, ground to the aircraft, container to the aircraft, and then the nozzle to the aircraft. When disconnecting, use reverse order.

Servicing directly from cans into aircraft is an uncommon procedure to be used only as a last resort. A funnel and chamois may be the only means available to filter the fuel, but because this may increase the possibility of static electricity, use the following precautions: connect ground to aircraft; maintain direct metal-to-metal contact of the can to the funnel and funnel to aircraft or use bonding cables as necessary.

Fuel stored in drums or cans is especially susceptible to water accumulation and scale from the container's interior. Check thoroughly for contamination and use a filter while transferring.

Under no circumstances should a plastic bucket or other nonconductive container be used for fuel servicing.

Fueling during lightning storms. Extreme caution should be observed during electrical storms. If storm is severe or directly overhead, stop fueling until it has passed.

Fuel spills and fires

Spills of either gasoline or jet fuel present a potentially serious fire hazard to personnel, aircraft, and equipment each time they occur. Therefore, every effort should be made to prevent them.

Following are recommendations to minimize the number of accidental spills:

From General Aviation Ground Operations Safety Handbook, National Safety Council.

TECHNICAL INFORMATION SUPPLEMENT #4

*Fuel-servicing personnel should be thoroughly trained. Proper grounding and bonding procedures should be observed. During overwing fueling, the fueler must never leave the hose nozzle unattended, nor the nozzle trigger wedged or tied in an open position. The fueler should also devote his full attention to the job, making frequent checks of the amount of fuel in the tank to prevent overfilling. During underwing fueling, the fueler must also understand the operation of the automatic shut-off in the aircraft fueling system and be able to monitor its operation at all times.

*All fueling equipment must be properly maintained. It should be inspected daily and repaired as required.

*Every spill should be reported and investigated so that remedial action can be taken.

In the event a fuel spill does occur, it should be treated as a potential fire source and the following action taken: Note that if these are in conflict with local airport regulations, the local regulations take precedence.

*The flow of fuel should be stopped, if possible, by closing the emergency shut-off valve immediately. Depending upon the nature of the spill, it may be necessary to evacuate the aircraft.

*The airport fire department should be notified (except for small spills as defined below) and supervisory personnel should be notified to make sure that operations in progress may either be continued safely, or halted until corrective measures have been taken.

Small spills of less than 18 in. (0.5 m) in any direction are normally considered minor. Other than normal standby of ramp personnel with fire extinguishers, no other precautions are considered necessary.

Small spills, of not over 10 ft (3 m) in any dimension or not over 50 sq ft (5.5 m²) in area and not of a continuing nature, should have a fire guard posted with at least one fire extinguisher of a 20B rating, if fueling rate is not over 200 gallons per minute (13 liters/sec.). (Extinguishers of higher rating are necessary if fueling rates are in excess of 200 gallons per minute.) The spill should be cleaned up by using absorbent cleaning agents unless it is in an area where no activity will occur, in which case it may be left to evaporate. A supply of absorbent material carried on fuel trucks and ramp vehicles would be readily available should the need arise.

The volatility of the fuel may be a major factor in the initial severity of the hazard created by a spill. Aviation gasoline and other low flash-point fuels at normal temperatures and pressures will give off vapors that are capable of forming ignitable mixtures with the air near the surface of the liquid, whereas this condition does not normally exist with kerosene-base fuels. Each spill will have to be treated as an individual case because of such variables as wind and weather conditions, equipment arrangement, personnel, and available emergency equipment.

From General Aviation Ground Operations Safety Handbook, National Safety Council.

TECHNICAL INFORMATION SUPPLEMENT #4

Large spills, of over 10 ft in any dimension and over 50 sq ft in area or of a continuing nature, are considered extremely hazardous. The airport fire department should be called at once.

It may be necessary to evacuate the aircraft if it appears that the spill may present a serious fire exposure to the aircraft. Personnel should not walk through the spill area.

Motorized equipment within spill areas should not be started before a spill is cleaned up. However, if the engine is already running and the hazard to personnel is not judged too severe, the vehicle or vehicles may be driven out of the area.

Motorized equipment outside a spill area should be moved away or shut down as quickly as possible. If the fuel-servicing equipment is moved, it should be determined that the fuel hose or pipe to the aircraft has first been disconnected and stowed.

Large spills of fuel should be blanketed with foam. The spill should then be washed away with water and any residue allowed to evaporate before the area is used again. These fuels should not be washed down sewers or drains unless there is no alternative and it has been approved by the airport fire department. If this is done, the sewers should be flushed with large quantities of water. Consult federal and local environmental pollution regulations and ordinances before establishing standard cleanup procedures.

Following a spill, depressed areas such as flap wells or wing sections of the aircraft involved should be inspected for an accumulation of fuel or fuel vapors and any fuel that is discovered should be removed.

All cargo should be inspected, and if any is contaminated with fuel, it should not be placed aboard until the fuel has been removed or evaporated.

The aircraft should be removed from the fuel area before its engines are started, unless the spill has been completely eliminated.

It is hoped that by observing these precautions, a fire resulting from a fuel spill will be avoided.

Fuel spill fires. In the event a fire does occur, the following procedures are recommended and should be performed simultaneously if sufficient personnel are available:

*The airport fire department and appropriate company management personnel should be called immediately.

*If an aircraft, fuel truck, or spilled fuel catch fire, the aircraft should be immediately evacuated. If fire prevents the use of the normal passenger loading stands, passengers should evacuate through the emergency exits.

*Fight the fire with all equipment available. Be sure that all members of a fueling crew in particular, and all ramp personnel in general, have been thoroughly trained in the use of fire extinguishers. Their training should include practice drills in extinguishing flammable liquid fires.

From General Aviation Ground Operations Safety Handbook, National Safety Council.

TECHNICAL INFORMATION SUPPLEMENT #4

*If possible, remove the fuel truck from the fire area following the precautions discussed above.

Ramp vehicles. Vehicles that are not properly maintained present a fire hazard during fueling operations. Such things as electrical system shorts, arcs across terminals, sparks from exhausts, or backfires can ignite flammable vapors and should be corrected when first noticed.

Fuel toxicity

Aviation fuels are physically hazardous both from inhalation of vapors and direct skin contact.

Inhalation. High concentration of vapors will occur around fuel spills, in fuel tanks, and possibly under wing areas from tank vents during prolonged fueling of larger aircraft on still days. These areas should be avoided by personnel. Although turbine fuel vapors are mostly just unpleasant, overexposure will cause reduced oxygen intake and possible suffocation.

Aviation gasoline is relatively more toxic due to the presence of tetraethyl lead vapors. This exposure has been reduced somewhat with wide use of low-lead products. The hazard still exists, however, and prolonged inhalation of vapors should be avoided.

Contact. Direct physical contact with fuels is the most common exposure. Because fuels dissolve oils from the skin, dryness and irritation results, which may be termed "chemical burn." Frequent exposure can result in dermatitis and will require medical treatment. If frequent exposure persists over long periods (such as years), this dermatitis can become very difficult to cure.

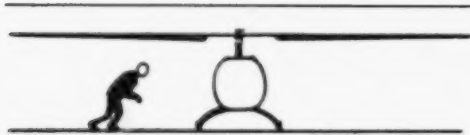
Remedies. In case of skin contact, especially a heavy dousing, wet clothing must be removed and the affected areas washed thoroughly with soap and water. Eyes should be rinsed liberally with water. In cases of both moderate and severe exposure, seek medical assistance in treatment of chemical burn dermatitis and eye irritation.

If fuel enters cuts or sores on the skin, wash with soap and water immediately and apply an antiseptic. Seek medical help as necessary.

From General Aviation Ground Operations Safety Handbook, National Safety Council.

Helicopter Safety

Safety Around Helicopters



1. Approach or leave machine in a crouching manner (for extra clearance from main rotor).



2. Approach or leave on the down slope side (to avoid main rotor).



3. Approach or leave pilot's field of vision (to avoid tail rotor).



4. Carry tools horizontally, below waist level (never upright or over shoulder).



5. Hold onto hard hat when approaching or leaving machine, unless chin straps are used.



6. Fasten seat belt on entering helicopter and leave it buckled until pilot signals you to get out.



7. If leaving machine at the hover, get out and off in one smooth, unhurried motion.

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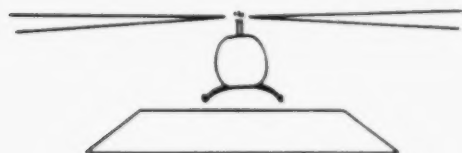
TM #1

Helicopter Safety

(Continued)



8. Do not touch bubble or any of the moving parts (tail rotor linkage, etc.).



9. Keep landing pad clear of loose articles.



10. Loading assistants should always use plastic eye shields.



11. After hooking up cargo sling, move forward and to side to signal pilot.



12. When directing machine for landing, stand with back to wind with arms outstretched toward landing pad.

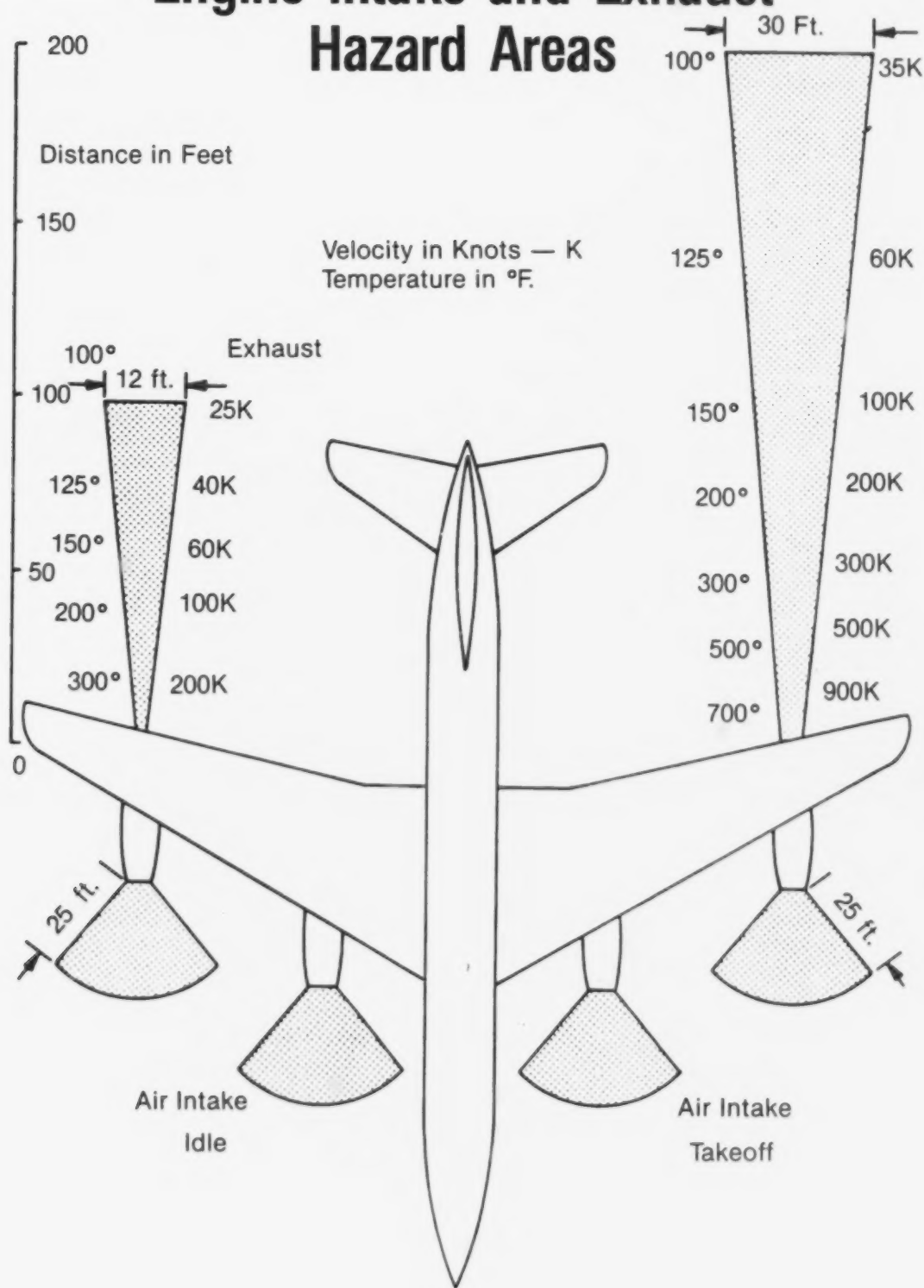


13. When directing pilot by radio, give no landing instructions that require acknowledgement as pilot will have both hands busy.

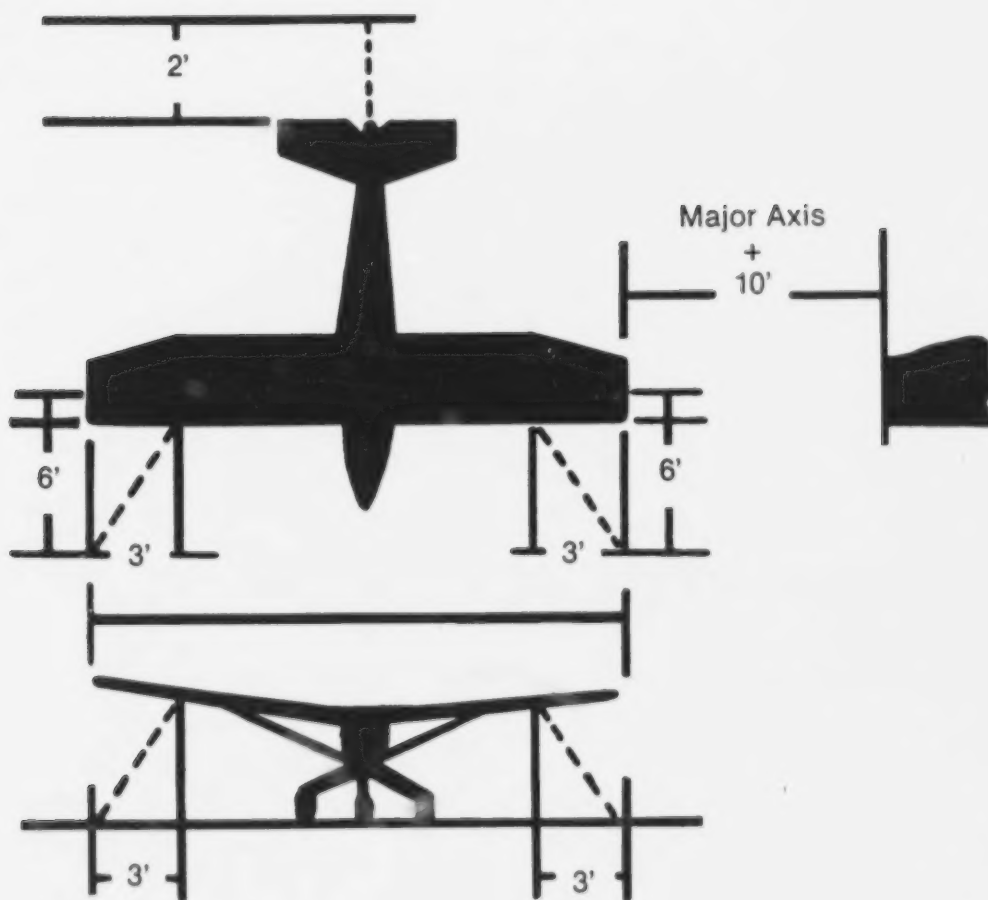
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TM #2

Engine Intake and Exhaust Hazard Areas



Tiedown Dimensions



Tornado Frequency

(Ten-Year Period)



G104A-63

Continental U.S. Storm Belts



Primary Hurricane Danger Zone.

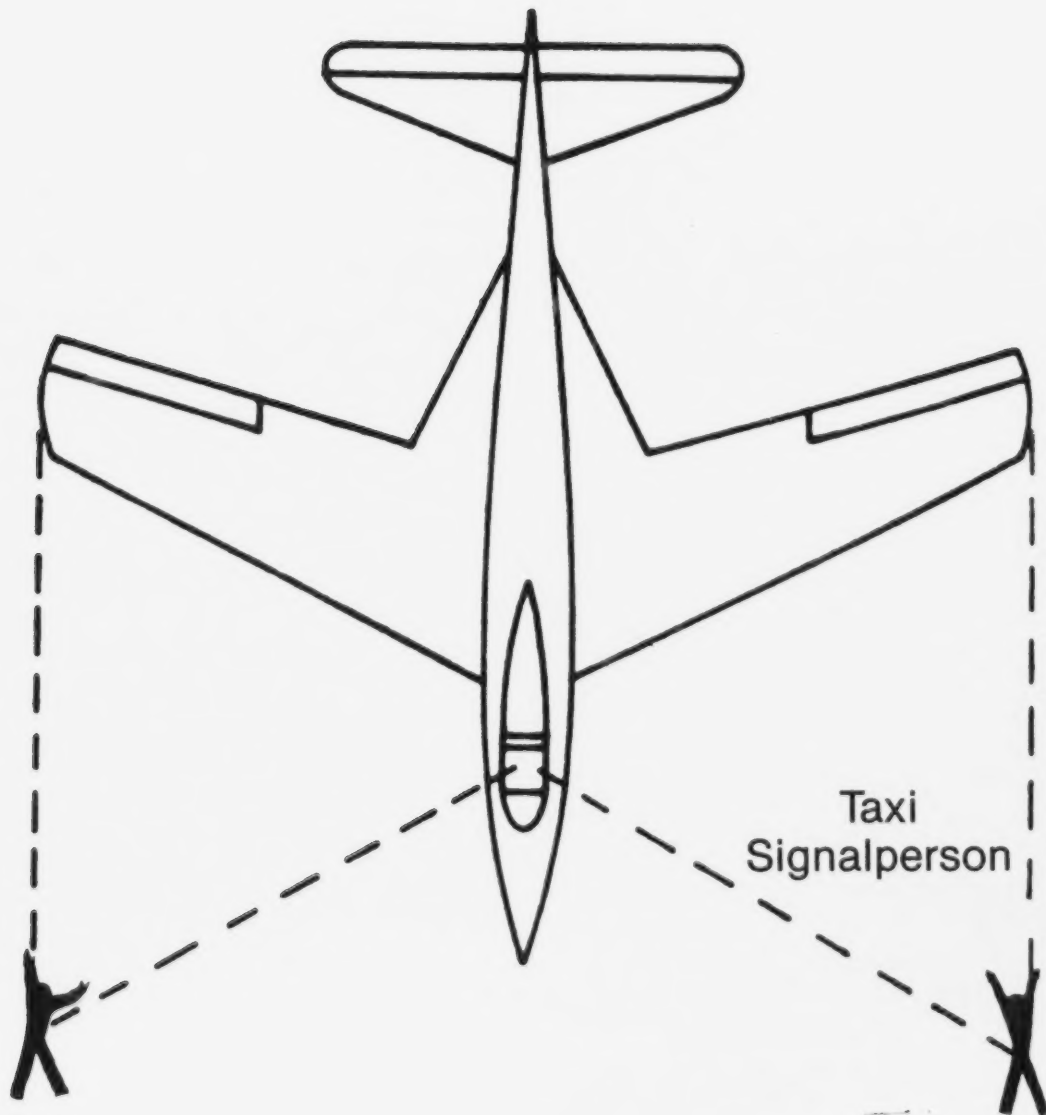


Fringe Area.



Tornado Belt.

Position of Taxi Signalperson



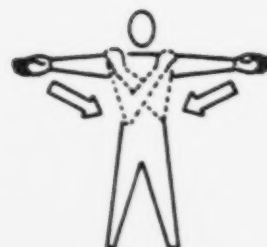
Helicopter Operating Signals



Start Engine



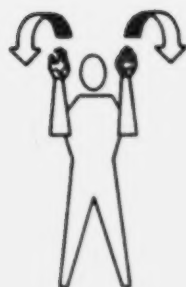
Engage Rotor



Stop Rotor



Stop



Move Back



Move Forward



Move Right



Move Left

Helicopter Operating Signals (Continued)



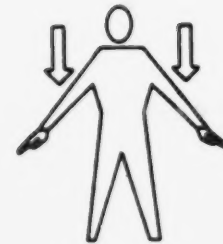
Take Off



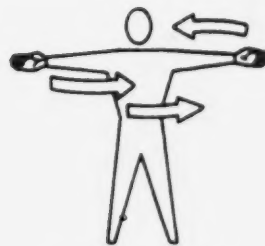
Landing
Direction



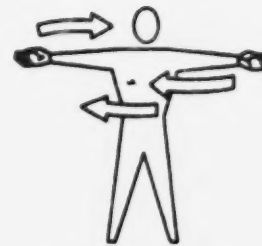
Go Up



Go Down

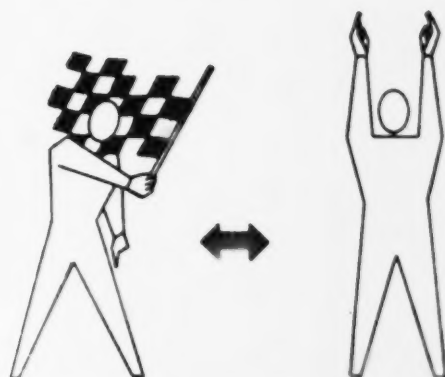


Swing Tail
to Right

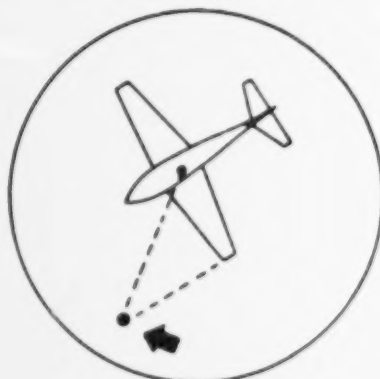


Swing Tail
to Left

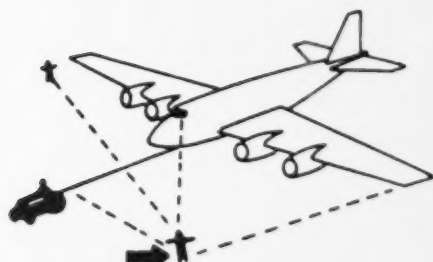
Standard FAA Hand Taxi Signals



Flagman Directs Pilot to
Signalman if Traffic
Conditions Require



Signalman's
Position



Signalman Directs
Towing



Stop



Come Ahead



Emergency
Stop



Cut Engines



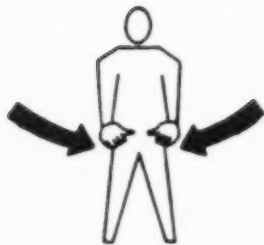
Start Engines



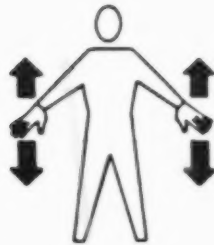
Pull
Chocks

Standard FAA Hand Taxi Signals

(Continued)



Insert Chocks



Slow Down



All Clear (O.K.)



Left Turn



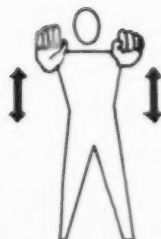
Right Turn



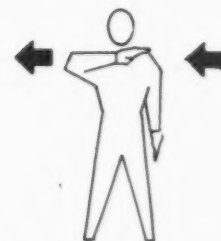
Night
Operation



Proceed to Next
Signalman or
Proceed at Your Own Discretion



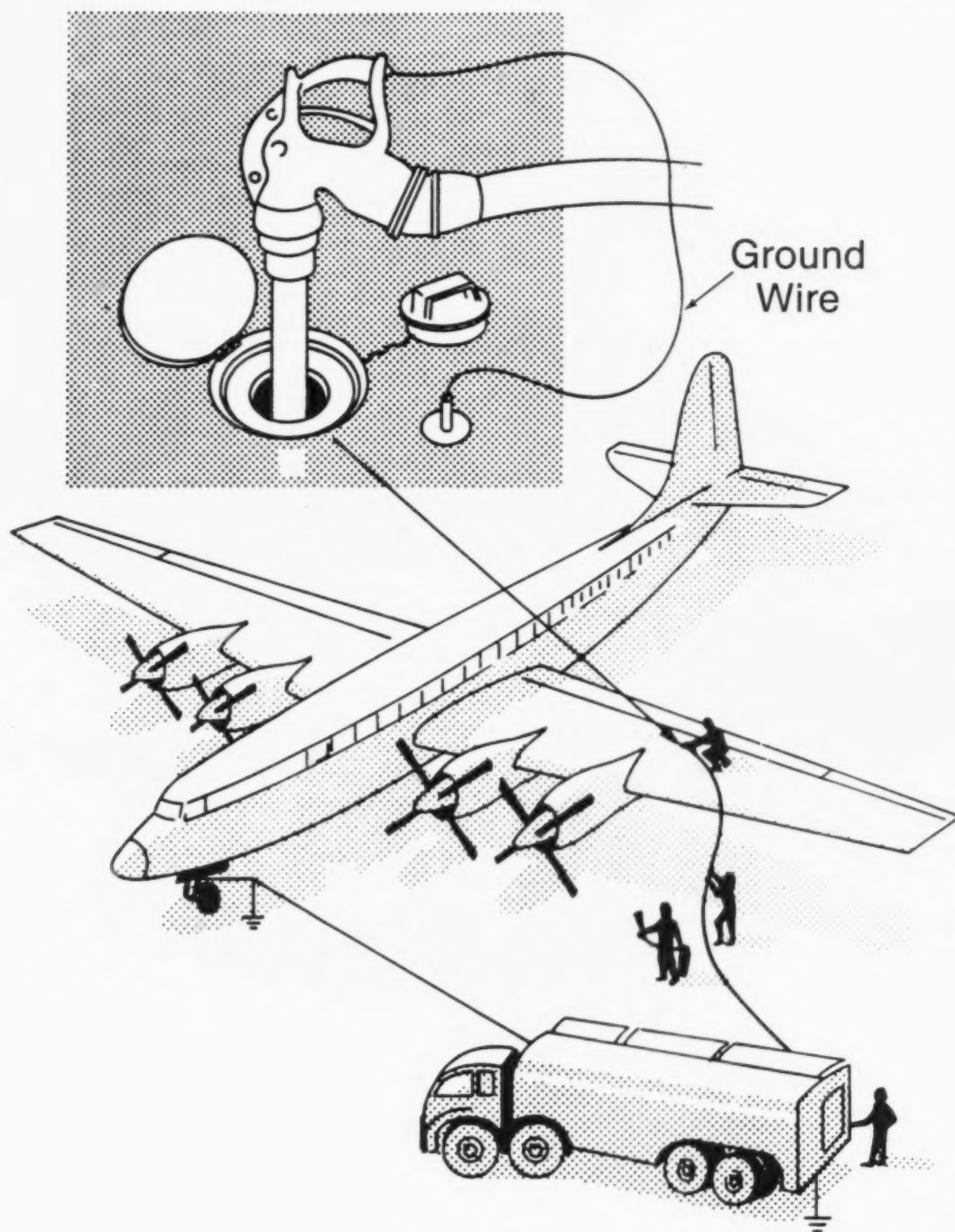
Brake Set



Stop Engines

(NOTE: Hand signals to aircraft pilots must be executed in a clear, sharp manner in order to avoid confusion. Signals may vary and light wands are used at night.)

Refueling an Aircraft



67

TM #12

G104A-77

GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

WORKBOOK SUPPLEMENT #1--Use Terms Related to Ground Operations
for Turbine and Reciprocating Engines to Complete a Word Search

Language is the ladder to competency in a technical field. Complete this word search carefully in order to increase your aviation vocabulary.

Using Technical Information Supplement #1, write the correct term in the blank preceding the definition, and then circle the term in the word search on the page that follows.

- | | |
|-------|---|
| _____ | A. Area of an airfield where airplanes are parked |
| _____ | B. Open-ended tube that faces directly into the relative airstream of an aircraft and picks up ram (pitot) pressure to be used in an airspeed indicator |
| _____ | C. Airplane whose wheels have been replaced with skis so it can be operated on snow or ice |
| _____ | D. Main spanwise structural member of a wing or other airfoil |
| _____ | E. Physiological point at which pain begins in the human body |
| _____ | F. Special anchoring provision on an airport surface by which airplanes may be secured when they are parked |
| _____ | G. Usually a localized storm produced by a cumulonimbus cloud |
| _____ | H. Storm characterized by high winds and little or no rain |
| _____ | I. Airplane designed to land and take off from the surface of water |
| _____ | J. Internal engine damage which occurs from injection of foreign objects into the engine gas path |
| _____ | K. Form of heavier-than-air, rotor-wing aircraft whose lift is produced by engine-driven rotors, which are essentially long, narrow airfoils |
| _____ | L. Airplane designed to operate from surface of land rather than water or snow |

- _____ M. Device used to spoil lift by disrupting
airflow over an aerodynamic surface
- _____ N. Function of certain fuel additives which
kill microbes and bacteria living in water
in aircraft fuel tanks
- _____ O. Thick; having high resistance to flow
- _____ P. Hinged linkage between piston and cylinder
of an oleo shock strut; allows piston to
move in and out, but restrains it from
rotating
- _____ Q. To move an airplane on the ground under
its own power
- _____ R. Aircraft landing gear shock strut that
absorbs initial landing impact by trans-
ferring oil from one chamber to another
through a restricting orifice
- _____ S. Ease with which fluids change from a liquid
to a vapor
- _____ T. Wire or electrical connection used to ground
a component or structure to an airframe
- _____ U. Power unit used to provide auxiliary air,
hydraulic, and electrical power
- _____ V. Electrical charge which may be built by
friction upon a nonconductive surface
- _____ W. Marks on the aircraft's nose gear which show
the maximum allowable travel off-center
for the nose gear
- _____ X. To remove an undesirable constituent from
a substance or region by physical or chemical
means
- _____ Y. Aircraft designed to take off or land on
either land or water
- _____ Z. Condition which occurs from an aircraft
being ground handled in a rough and unpro-
fessional manner

WORKBOOK SUPPLEMENT #1

D C V B W X Q R B C D L M N P C B F Z X E L V W B F G H J S
 C K L G N A S V F L I G H T L I N E Y G H J K L M N P R T L
 L M P F R T W X Z L B D G Q R S T F A C G F D B L Q R S T J
 V W Q L Z V L H R U V B M N T V B M M O L E O S T R U T C D
 M Q R B C W M A S T W C L P S W A C L N W B X Y L M Z B B F
 Q B S O D L A N D P L A N E R D Z D K P V C S Z R N Y C Z G
 R G T N F X N G T S X D K Q T H U N D E R S T O R M X D Y H
 S H B D G V Q A U R Y F J C Q X Y F J Q S R A P S P W F X J
 A U X I L I A R Y P O W E R U N I T H E U D T B C Q V H W K
 M B C N H S R R V Q Z J H R P V X G B R T F I C A R T E V L
 P Q D G J C S A W P B G T A X I W U G S S G C D V S S L T M
 H G E W K O V S X O I H G S N Z T H F T R H E F E T R I S N
 I V F I L U T H N N O J F T M T O W D V Q J L G N V Q C R P
 B L G R M S W G V M C K D V O B T L C W P K E H G W P O Q Q
 I M H E N B I R Z L I L C T L C S I B X T L C J E X N P P R
 A N J Y P E N Q B K D M I W I D R M Z Y N O T K Z Y M T N S
 N P K Y R R D S S E A P L A N E Q I Y Z M N R L Y Z S E M T
 G S L O Q Q S T P J L N B X J F D T M A R K I Q X B K R L V
 T T F W R P T P O H A P Z Y H G P O W C K Q C M U C I L K W
 B R M V S N O Z I G C Q Y Z G H N Q W D J R I N W E P K J X
 D X N T T M R X L F T R X B F J M R V N H S T P V D L J H Y
 J W P S W L M W E D I S W V O L A T I L I T Y A T F A I G Z
 K Z Q R X Z J K R C O T V C D K L S T F G V W R S G N H N B
 L B D C F G H J K L N T H R E S H O L D O F P A I N E M L K

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WORKBOOK SUPPLEMENT #2--State Facts Related to Ground Handling
and Servicing Safety

Ground handling and servicing activities which an aviation maintenance technician participates in are among the most dangerous of the job. Knowledge and attitude are the technician's only defense against serious or fatal injury. This workbook supplement will help to expand your knowledge of related safety practices. Your job is to develop and retain the attitude which will put these practices to work to prevent injury and save lives.

PART I

A. Select true statements related to electrical cords. Circle the letter before each correct answer.

1. Be sure all electrical equipment is connected with two-wire extension cords of adequate capacity.
2. Frayed cords can be used until the wires are exposed.
3. Replace all cracked plugs.
4. Never handle electrical equipment on wet surfaces or in wet shoes.

B. Complete the following statements about compressed gases. Write the correct answers in the blanks.

1. Most shop compressed air is held in the tanks and lines under pressure of about _____ psi.
2. Because it is possible to inject air into your bloodstream if a stream of air is blown across a cut in your skin, air dusting guns must have a discharge pressure of _____ psi or less.
3. Oxygen and nitrogen are usually stored in steel cylinders at a pressure of about _____ psi.
4. All gas cylinders that are not connected into the system must have a safety _____ to protect the brass discharge valve.

5. Oxygen must never be allowed to come in contact with _____ products because this will cause extremely rapid (explosive) spontaneous combustion.

C. State facts related to machine tool safety.

1. State two items that should be known prior to using a machine tool.
 - a. _____
 - b. _____
2. Why are all machine power tools equipped with guards and safety covers?

3. Why should all cutting and drilling tools be properly sharpened?

4. Explain how large holes are cut in thin sheet metal.

5. When is eye protection used around machine tools? _____
6. The most important thing to do while operating a machine tool is

D. List four general fire safety rules for hangar and shop.

1. _____
2. _____
3. _____
4. _____

E. List and define the four major classes of fires.

1. _____
2. _____
3. _____
4. _____

F. List the three requirements for fire.

1. _____
2. _____
3. _____

G. Match the types of extinguishing agents to types of fires for which they are best suited. Write the correct letters in the blanks. (Some answers may be used more than once.)

TYPE OF FIRE	EXTINGUISHER
_____ 1. Class A cabin fire - paper	a. Water
_____ 2. Class C cabin fire	b. CO ₂
_____ 3. Class B shop fire	c. Halogenated hydrocarbons
_____ 4. Class D shop fire	d. Dry-powder
_____ 5. Class C shop fire	e. Dry-chemical

H. Match the color-coded symbols to types of fires. Write the correct letters in the blanks.

_____ 1. Class B	a. Green
_____ 2. Class D	b. Red
_____ 3. Class A	c. Blue
_____ 4. Class C	d. Yellow

WORKBOOK SUPPLEMENT #2

I. Complete the following statements related to ear protection. Write the correct answers in the blanks.

1. The flight line of a modern airport is a high-_____ area.
2. There are both _____ and _____ protectors for ears.
3. The _____ mechanism of the ear is an area where irreversible damage occurs from continued exposure to high noise levels.
4. Humans can become accustomed to high levels of noise, but continued exposure to high noise levels, even though they are below the _____, is still damaging.

PART II

Prior to completing this portion of Workbook Supplement #2, make sure you have read Technical Information Supplement #2 and the reading assignment in AC-65-9A II:507, 508.

A. State facts related to flight line safety.

1. How much did FOD cost the aviation industry in 1984? _____
2. How many instances of human ingestion occurred in the Boeing /3/ in the years 1979-1983? _____
3. What is the pulling force at a distance of 3 feet? _____
2 feet? _____
(NOTE: Use Figure 1 in Technical Information Supplement #2.)
4. In the years 1979, 1980, and 1981, how many propeller- and rotor-to-person accidents were reported? _____
5. How do propeller- and rotor-to-person accidents differ from other aircraft accidents? _____

WORKBOOK SUPPLEMENT #2

6. When should an ignition switch test be made? _____

7. What is one of the simplest ways to prevent propeller- and rotor-to-person accidents when dealing with passengers? _____

B. Complete statements related to general safety practices. Write the correct answers in the blanks.

1. _____ lights should be used in hangers, shops, and on the flight line.

2. All lights and equipment should be switched to _____ prior to connecting and disconnecting.

3. Disregard of the safety rules for the use of power cords may result in _____ and _____ with damage into _____ of dollars and loss of _____.

4. All connections in a compressed air system should be kept in a " _____."

5. The compressed air system should have _____ sumps installed, and they should be drained at regular intervals.

C. State facts related to general safety practices. Write the correct answers in the blanks.

1. What can occur if compressed air is used to clean hands or clothing?

2. How should air hoses be stored when not in use? _____

WORKBOOK SUPPLEMENT #2

3. How should oil and grease spills be treated by the aircraft maintenance technician? _____

 4. What could be the possible consequence of oil or cleaning fluid being emptied into floor drains? _____
 5. What should be used when initially inflating tires on wheels equipped with locking rings? _____
 6. What should be used on high-pressure air bottles to eliminate overinflating aircraft tires? _____
- D. Select precautions to observe when welding in a hangar. Circle the number in front of each correct answer.
1. No painting in progress
 2. No tire changing
 3. No open fuel tanks or work on fuel systems in progress
 4. No aircraft within 35 feet
 5. Area roped off and placarded
 6. Trained fire watchers in attendance at the above equipment
 7. Aircraft in towable condition, with a tug attached, aircraft brakes on, and a qualified operator on the tug with mechanics available to assist in the towing operation; hangar doors closed
 8. Fire extinguishing equipment of a minimum rating of 20B in the immediate area with 80B rated equipment as a backup
 9. Only qualified welders permitted to do the work

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WORKBOOK SUPPLEMENT #3--State Facts Related to Tiedown Procedures

Each year many aircraft are needlessly damaged by windstorms because of negligence and improper tiedown procedures. A storm can turn a local airport into a junkyard in a matter of minutes. If an aircraft is damaged during a windstorm, the chances are it was improperly secured or was not tied down at all. As an aviation maintenance technician, it is important for you to develop competency in the correct tiedown procedures.

Complete the following statements related to aircraft tiedown procedures. Write the correct answers in the blanks.

- A. The lightweight construction of an aircraft, along with its airfoil-shaped wings and tail surfaces or rotors, makes it highly susceptible to _____.
- B. _____ can occur throughout the year and may appear in almost any part of the country.
- C. Using figure 1-15 in EA-ITP-G 7:1:9 and Transparency Masters #1-#2, answer the following:
1. What is the safest way of carrying tools around helicopters?

 2. What type of safety gear should loading assistants wear?

- D. An aircraft should be protected by storing it in a storm-proof hangar or by _____.
- E. When a windstorm is anticipated, the aircraft should have all of the controls securely locked to prevent what type of damage?

- F. Control battens are used to lock the control surfaces to prevent _____.

WORKBOOK SUPPLEMENT #3

G. If a tailwheel aircraft is tied down facing away from the wind, the elevators should be locked in what position? _____

H. Special care must be taken when securing the spoilers that the ropes are not pulled tight enough to damage the _____ or _____ of the wing.

I. Why should the pitot tube head be covered? _____

J. Most airports have tiedown areas with anchors permanently embedded into hard surfaced ramps. These may be in the form of individual anchors or tiedown cables.

According to the above statement, describe how many tiedowns should be placed in small aircraft and the position of each. _____

K. What is the strongest material used as a rope for tying down an aircraft? _____

L. What type of knot is commonly used to tie down an aircraft with a rope? _____

M. When securing an aircraft with a chain, the snap would be used only to secure a _____ through _____

N. What is the main reason for flooding the float compartments of sea-planes with water? _____

When should this be done? _____

WORKBOOK SUPPLEMENT #3

- O. Explain how a ski plane is properly secured to provide the highest degree of protection from high winds. _____

- P. List the steps in securing a helicopter for high winds.
1. _____
 2. _____
 3. _____
 4. _____
- Q. The position of the main and tail rotor blades are specified by the _____ and secured to the structure by the method in the specified _____.

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WORKBOOK SUPPLEMENT #4--State Facts Related to Aircraft
Jacking and Hoisting

The aviation maintenance technician must be familiar with the jacking of aircraft in order to perform maintenance and inspection. Jacking procedures and safety precautions vary for different types of aircraft. Extensive aircraft damage and serious personal injury have resulted from careless or improper jacking procedures.

Complete the following statements related to aircraft jacking and hoisting. Write the correct answers in the blanks.

- A. To lift only one wheel from the floor to change a tire or to service a wheel or brake, some manufacturers have made provisions on the _____ for the placement of a short _____.
- B. Be very sure when lifting the aircraft by the one-wheel method that you do not place the jack under the _____ or in any location that is not specifically approved by the _____.
- C. To prevent the aircraft from moving while it is on the jack, the wheels that are not jacked should be securely _____.
- D. The most important consideration when jacking an aircraft is to follow the _____ in detail.
- E. Most of the higher-capacity jacks have _____ - _____ to prevent the jack from inadvertently retracting.
- F. Jacks that do not have the screw-type safety collars will usually have holes drilled in the strut so _____ can be inserted to guard against the jack retracting.

WORKBOOK SUPPLEMENT #4

- G. Some aircraft can have their tails held down by weights placed on the _____ spar of the _____ stabilizer. Before using this procedure, be sure that it is approved by the _____ and that only the recommended amount and type of _____ is used.
- H. Before lowering the aircraft, be sure to remove all of the _____ and _____ that fit comfortably when the aircraft is raised, but which will cause damage if the aircraft is lowered onto it.
- I. Use a hoist of sufficient capacity, and where necessary, use _____ between the cables to prevent side loads on the attachment points.

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WORKBOOK SUPPLEMENT #5--State Facts Related to Aircraft Towing

Towing aircraft can be a hazardous operation, causing damage to the aircraft and injury to personnel if done recklessly or carelessly. As an aviation maintenance technician it is imperative that you develop competency in the principles involved with aircraft towing, as well as in the actual performance of aircraft towing. Answer the following questions. Write the correct answers in the blanks.

- A. Why must there be a person in the cockpit when an aircraft is being towed?

- B. How are aircraft equipped with tailwheels usually towed?

- C. When is a steering bar used on aircraft equipped with tricycle landing gear?

- D. What is the function of a wingwalker? _____

- E. How many people should be stationed between the towing vehicle and the nosewheel to observe the tow bar? Explain: _____

- F. What should be available in case of an emergency, particularly for an aircraft with faulty brakes? _____
- G. When should aircraft brakes be applied during towing, and on whose command?

H. In general, how far apart should rows of parked aircraft be?

I. What must be done prior to towing aircraft across runways or taxiways?

J. What should be done immediately after parking an aircraft in a hangar?

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WORKBOOK SUPPLEMENT #6--State Facts Related to Aircraft
Servicing and Ground Support Equipment

Servicing aircraft is a routine maintenance chore. This chore requires the skillful use of many types of ground support equipment. The aviation maintenance technician must use the correct material and equipment and use them properly when performing these procedures or the aircraft can be lost. A significant number of accidents occur each year due to the failure of technicians to service tanks with the proper fluid, caps are left off filler openings, and many other careless reasons. Don't let this happen to you - BE A PROFESSIONAL! Answer the following questions related to aircraft fueling and defueling. Answer the following questions. Write the correct answers in the blanks.

- A. What are two uses for an auxiliary electrical power unit? _____

- B. What is a "mule"? _____

- C. When servicing an oxygen system using manifolded cylinders, which valves are opened first? _____

- D. What must be remembered when positioning a ground electrical power unit near an aircraft? _____

- E. When is it necessary to pre-oil a reciprocating aircraft engine? _____

F. Why is there a provision for extra space in an aircraft's oil tank?

G. When can a petroleum product be extremely toxic?

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WORKBOOK SUPPLEMENT #7--State Facts Related to Aircraft Fueling
and Defueling

There are many types of aircraft engines and there are many types of fuel. There are many types of airports and aircraft so there is a great variety in the manner in which fuel is delivered to the aircrafts' fuel tanks. Part of your job as an aviation maintenance technician is to ensure that all aircraft for which you are responsible have the correct fuel delivered to their tanks in the correct manner. Don't be fuelish! Take this simple job seriously. Acquire, retain, and use the knowledge and skills required to perform this task professionally. Answer the following questions. Write the correct answers in the blanks.

- A. What are the names and color codes for the three grades of aviation gasoline in common civilian use? _____

- B. Which of the two types of turbine fuel is used by almost all of civilian jet aircraft, Jet A or Jet B? _____
- C. What is volatility? _____
- D. What is the vapor pressure equipment for aviation gasoline at 100°F? _____

- E. What should be done about spilled fuel? _____

- F. What can happen if static bonding wires are not properly connected? _____

- G. State the most common contamination problem with aviation fuel, and describe its usual source. _____

WORKBOOK SUPPLEMENT #7

- H. How has the problem of microbial growths in turbine aircraft fuel tanks been overcome? _____

- I. What is the advantage and disadvantage of filling fuel tanks completely when storing an aircraft in a hangar? _____

- J. How should fuel appear in the sight gages prior to refueling? _____
- K. Are the static bonding wires connected before or after removing the fuel tank cover and nozzle dust cap? _____
- L. When defueling an aircraft, what is the fuel checked for before it is pumped into storage tanks? _____

- M. What type of fire extinguisher should be on hand when refueling? _____
- N. How should the tank truck be parked relative to the aircraft when refueling? _____

- O. What action should be taken if fuel is spilled on your body? _____

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ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #1

- | | |
|--------------------------|-------------------|
| A. Flight line | W. Tow limit mark |
| B. Pitot tube | X. Scavenge |
| C. Ski plane | Y. Amphibian |
| D. Spar | Z. Hangar rash |
| E. Threshold of pain | |
| F. Tiedown | |
| G. Thunderstorm | |
| H. Windstorm | |
| I. Seaplane | |
| J. Foreign object damage | |
| K. Helicopter | |
| L. Land plane | |
| M. Spoiler | |
| N. Biocidal action | |
| O. Viscous | |
| P. Torque links | |
| Q. Taxi | |
| R. Oleo strut | |
| S. Volatility | |
| T. Bonding wire | |
| U. Auxiliary power unit | |
| V. Static Electricity | |

ANSWERS TO WORKBOOK SUPPLEMENTS

D	C	V	B	W	X	Q	R	B	C	D	L	M	N	P	C	B	F	Z	X	E	L	V	W	B	F	G	H	J	S
C	K	L	G	N	A	S	V	F	L	I	G	H	T	L	I	N	E	Y	G	H	J	K	L	M	N	P	R	T	L
L	M	P	F	R	T	W	X	Z	L	B	D	G	Q	R	S	T	F	A	C	G	F	D	B	L	Q	R	S	T	J
V	W	Q	L	Z	V	L	H	R	U	V	B	M	N	T	V	B	M	M	O	L	E	O	S	T	R	U	T	C	D
M	Q	R	B	C	W	M	A	S	T	W	C	L	P	S	W	A	C	L	N	W	B	X	Y	L	M	Z	B	B	F
Q	B	S	O	D	L	A	N	D	P	L	A	N	E	R	D	Z	D	K	P	V	C	S	Z	R	N	Y	C	Z	G
R	G	T	N	F	X	N	G	T	S	X	D	K	Q	T	H	U	N	D	E	R	S	T	O	R	M	X	D	Y	H
S	H	B	D	G	V	Q	A	U	R	Y	F	J	C	Q	X	Y	F	J	Q	S	R	A	P	S	P	W	F	X	J
A	U	X	I	L	I	A	R	Y	P	O	W	E	R	U	N	I	T	H	E	U	D	T	B	C	Q	V	H	W	K
M	B	C	N	H	S	R	R	V	Q	Z	J	H	R	P	V	X	G	B	R	T	F	I	C	A	R	T	E	V	L
P	Q	D	G	J	C	S	A	W	P	B	G	T	A	X	I	W	U	G	S	S	G	C	D	V	S	S	L	T	M
H	G	E	W	K	O	V	S	X	O	I	H	G	S	N	Z	T	H	F	T	R	H	E	F	E	T	R	I	S	N
I	V	F	I	L	U	T	H	N	N	O	J	F	T	M	T	O	W	D	V	Q	J	L	G	N	V	Q	C	R	P
B	L	G	R	M	S	W	G	V	M	C	K	D	V	O	B	T	L	C	W	P	K	E	H	G	W	P	O	Q	Q
I	M	H	E	N	B	I	R	Z	L	I	L	C	T	L	C	S	I	B	X	T	L	C	J	E	X	N	P	P	R
A	N	J	Y	P	E	N	Q	B	K	D	M	I	W	I	D	R	M	Z	Y	N	O	T	K	Z	Y	M	T	N	S
N	P	K	Y	R	R	D	S	S	E	A	P	L	A	N	E	Q	I	Y	Z	M	N	R	L	Y	Z	S	E	M	T
G	S	L	O	Q	Q	S	T	P	J	L	N	B	X	J	F	D	T	M	A	R	K	I	Q	X	B	K	R	L	V
T	T	F	W	R	P	T	P	O	H	A	P	Z	Y	H	G	P	O	W	C	K	Q	C	M	U	C	I	L	K	W
B	R	M	V	S	N	O	Z	I	G	C	Q	Y	Z	G	H	N	Q	W	D	J	R	I	N	W	E	P	K	J	X
D	X	N	T	T	M	R	X	L	F	T	R	X	B	F	J	M	R	V	N	H	S	T	P	V	D	L	J	H	Y
J	W	P	S	W	L	M	W	E	D	I	S	W	V	O	L	A	T	I	L	I	T	Y	A	T	F	A	I	G	Z
K	Z	Q	R	X	Z	J	K	R	C	O	T	V	C	D	K	L	S	T	F	G	V	W	R	S	G	N	H	N	B
L	B	D	C	F	G	H	J	K	L	N	T	H	R	E	S	H	O	L	D	O	F	P	A	I	N	E	M	L	K

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #2

Part I

A. 3, 4

- B. 1. 100
2. 30
3. 2,000
4. cap
5. petroleum

- C. 1. a. Be familiar with tool operation
b. Be familiar with the tool's safety features
2. To protect the operator
3. A dull or improperly sharpened tool causes excessive force to be used and as a result, the work may be grabbed or thrown out of the machine
4. Securely clamp the metal to a drill press table
5. Always use eye protection around machine tools
6. Keep thinking while you are using the machine

- D. 1. Combustibles must be stored in proper containers and in areas where spontaneous combustion cannot occur
2. Never sweep spilled fuel or dried paint overspray with a dry broom
3. Provide for exits when putting aircraft in hangars
4. Be sure that fire extinguishers are marked, serviced, and never obstructed

- E. 1. Class A--Ordinary combustible materials such as wood, cloth, and paper
2. Class B--Fires involving flammable liquids
3. Class C--Fires involving energized electrical equipment
4. Class D--Fires involving flammable metals, primarily magnesium

- F. 1. Fuel
2. Oxygen
3. Heat

- G. 1. a, c 4. d, e
2. e 5. b, e
3. c, e, b

- H. 1. b 3. a
2. d 4. c

- I. 1. noise
2. internal, external
3. inner
4. threshold of pain

ANSWERS TO WORKBOOK SUPPLEMENTS

Part II

- A. 1. \$50,000,000
2. 13
3. 140 lbs., 300 lbs.
4. 54
5. These accidents usually result in serious injury or death
6. After an engine run and before the engine is shut down
7. Shut down the engine of fixed-wing or helicopter aircraft prior to boarding or deplaning passengers
- B. 1. Explosion proof
2. Off
3. explosions, fires, millions, life
4. no leak condition
5. water
- C. 1. Pressure can force debris into the skin causing infection
2. Hoses should be straightened, then coiled and stored
3. These spills should be immediately cleaned up or covered with an absorbent material
4. Fumes may be ignited
5. Tire cage guard
6. Pressure regulators
- D. 1, 3, 4, 5, 6, 8, 9

Workbook Supplement #3

- A. wind damage
- B. Localized thunderstorms
- C. 1. Horizontally, below waist level
2. Plastic eye shields
- D. Tying it down securely
- E. Structural damage
- F. wind damage
- G. Fully down
- H. leading, trailing edge
- I. So water, dirt, and other foreign objects cannot be blown into it
- J. Three, one to each wing and one to the tail
- K. Nylon

ANSWERS TO WORKBOOK SUPPLEMENTS

- L. The bowline knot
- M. free link, standing link
- N. To add weight; when it needs to be secured against high winds
- O. Pack loose snow over and around the skis and pour water over them so that they will freeze solid
- P.
 - 1. Head helicopter into anticipated direction of wind
 - 2. Position helicopter clear of any other helicopters, airplanes, or buildings by at least a rotor-span
 - 3. Set brakes and place chocks in front of and behind wheels
 - 4. If mounted on skis, tie securely to the ground
- Q. manufacturer, operations manual

Workbook Supplement #4

- A. strut, hydraulic jack
- B. brake housing, manufacturer
- C. chocked
- D. manufacturer's instructions
- E. screw-type safety collars
- F. lock pins
- G. main, horizontal, aircraft manufacturer, weight
- H. work stands, equipment
- I. spreader bars

Workbook Supplement #5

- A. To operate the aircraft brakes in the event of tow bar failure or other emergency
- B. By attaching the tow bar to the tow rings on the main landing gear; tailing wheel must be unlocked or the locking mechanism will be damaged
- C. When towing backward with a towing bridle or bar attached to the lugs on the main landing gear
- D. To ensure adequate clearance of any obstruction in the path of the aircraft

ANSWERS TO WORKBOOK SUPPLEMENTS

- E. None; under no circumstances should anyone be permitted to walk or ride between the nosewheel of an aircraft and the towing vehicle
- F. Chocks
- G. Only in emergencies, and then only upon command by one of the tow team members
- H. A distance great enough to allow immediate access of emergency vehicles in case of fire, as well as free movement of equipment and materials
- I. Contact the airport control tower (ground control) on the appropriate frequency for clearance to proceed
- J. Statically--ground the aircraft immediately

Workbook Supplement #6

- A. For supplying power for operating electrical equipment when the engine is not running and for supplying the high current demands for starting
- B. A hydraulic power supply which temporarily connects into the aircraft according to manufacturer and is used to supply pressure for ground operations
- C. First open the valve on the cylinder having the lowest pressure and let the oxygen flow until the pressure stabilizes. Then shut the valve off and open the cylinder having the next lowest pressure. Continue this process until the system is charged from the cylinder having the highest pressure
- D. Park the unit a full service cable length away in such a manner that a collision will not occur with any aircraft if the unit's brakes should fail
- E. Before starting a new or preserved engine, or one that has been idle for a period of time
- F. To allow for expansion
- G. When in vapor form

Workbook Supplement #7

- A. Grade 80/87 fuel is dyed red; grade 100 fuel is dyed green; grade 100 low-lead is dyed blue
- B. Jet A
- C. A measure of a fluid's ability to change from a liquid into a vapor and is usually expressed in terms of Reid vapor pressure

ANSWERS TO WORKBOOK SUPPLEMENTS

- D. Seven pounds per square inch or less
- E. Wipe up spilled fuel with absorbent material or blanket with foam and then flood with water
- F. A spark can occur within the fuel vapors that are rising from the tank filler opening, resulting in a serious fire
- G. Water; it condenses out of the air in the storage tank, the fuel truck, and even in the aircraft fuel tanks themselves
- H. A biocidal agent is added to turbine fuel
- I. Full tanks prevent the formation of condensation which can contaminate the fuel; however, changes in temperature can cause tanks which are completely full to overflow, creating a fire hazard
- J. Sight gages should show that the fuel is bright and clear
- K. Before removing the fuel tank cover and nozzle dust cap
- L. Contamination and for the proper identification
- M. Fire extinguishers suitable for a Class B fire (either CO₂, dry powder, or halogenated hydrocarbons)
- N. Parallel to the wing of the aircraft and the parking brake set
- O. Wash it off with soap and water as soon as possible

GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

PROJECT GUIDE #1--Perform Aircraft Tiedown

PURPOSE: To prepare the aviation maintenance technician to perform the normal procedures for securing light land planes.

REFERENCE MANUALS:

- A. EA-ITP-G 7:I:11, 12
- B. AC-65-9A 11:508-512

EQUIPMENT AND TOOLS NEEDED:

- A. Three tiedown anchors
- B. One light land plane and service manual
- C. One set of chocks
- D. Two 15-foot lengths and one 10-foot length of suitable rope
- E. One set of engine intake covers
- F. Pitot tube and static port covers
- G. Control battens for ailerons, rudder, and elevator

PROCEDURE:

- A. Position the aircraft as nearly as possible into the wind, and install chocks
- B. Consult aircraft manufacturer's service manual for specific details on securing your aircraft
- C. Place tiedown stakes in the ground

PROJECT GUIDE #1

- D. Install tiedown ropes using knots that will not bind (Figure 33)

(NOTE: Bowline and fishermen's bend are recommended. Refer to Technical Information Supplement #3.)

FIGURE 33



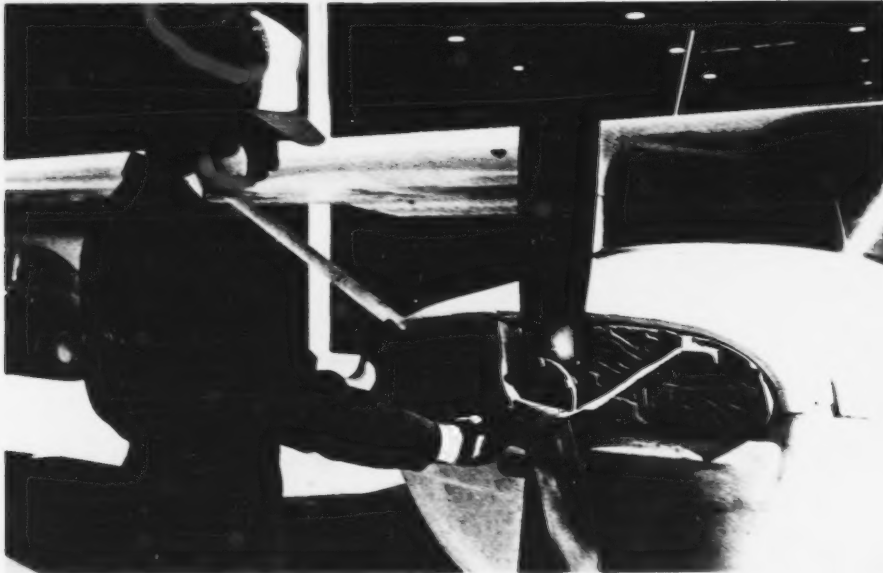
- E. Install pitot tube and static port covers (Figure 34)

FIGURE 34



F. Install engine intake covers (Figure 35)

FIGURE 35



G. Install control surface battens (Figures 36-38)

FIGURE 36



FIGURE 37

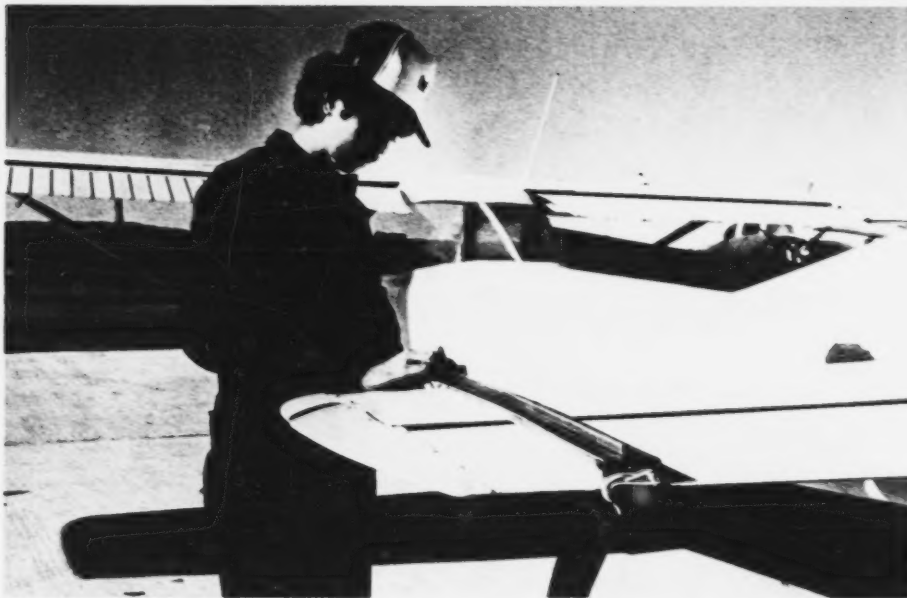


FIGURE 38



PROJECT GUIDE #1

- H. Have instructor check aircraft for security
- I. Return equipment and materials to instructor

GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

PROJECT GUIDE #2--Perform as Signalperson for Taxiing Aircraft

PURPOSE: Numerous accidents in aviation are attributable to improper techniques of taxiing aircraft. This project is to prepare the student to use proper techniques for taxiing aircraft and to allow the student to apply these techniques in a realistic setting.

REFERENCE MANUALS:

- A. AC-65-9A 520-523
- B. EA-ITP-G 7:14-17

EQUIPMENT AND TOOLS NEEDED:

- A. Aircraft
- B. Two sets of chocks
- C. Two fire extinguishers, 10 lb. minimum
- D. Ear protection (if required)
- E. Eye protection (goggles or safety glasses)
- F. 2-way radio
- G. Bull horn

SUPPLIES AND MATERIALS:

- A. Suitable course marking material
- B. One large red flag

PROCEDURE:

(NOTE: This project requires two signalpersons and four aircraft ground handling persons, one ground handling supervisor, and a qualified pilot or technician to be in the aircraft to be taxied.)

- A. Using a suitable colored marking material, lay out the taxi area course
- B. Discuss together the overall plan for the project; use Figure A (at end of project guide) and project guide

PROJECT GUIDE #2

- C. Position ground handling supervisor with red flag

(CAUTION: If supervisor raises red flag, all aircraft movement must stop! Signalpersons must give aircraft emergency stop signal. See Figure 39.)

FIGURE 39



NOTE: Supervisor must always be located where the person directing the aircraft and the aircraft's operator can see him. Instructor should be close to ground handling supervisor but not in the way.)

- D. Position personnel according to positions illustrated in Figure A
- E. One ground handler gives first instructions to aircraft operator

PROJECT GUIDE #2

1. Raise arms to attract operator's attention (Figure 40)

FIGURE 40



2. Give signal to set brakes (Figure 41)

FIGURE 41



PROJECT GUIDE #2

3. Give signal to pull chocks (Figures 42 and 43)

(NOTE: The other aircraft ground handler will pull the chocks.)

FIGURE 42



FIGURE 43



4. Aircraft operator will give signal to clear area underneath and around aircraft prior to engine start (Figures 44 and 45); ground handler will give the thumbs up signal when the area is clear (Figure 46)

FIGURE 44



FIGURE 45



FIGURE 46



PROJECT GUIDE #2

5. Give signal to start engine (Figure 47)

FIGURE 47



6. Give signal to turn over control of the aircraft to signalman when aircraft operator is ready (Figure 48)

FIGURE 48



- F. Signalman #1 will now use the necessary signals to direct aircraft and to guide it over desired path

(NOTE: Signalpersons will move as required to stay clear of aircraft propeller and remain in operator's view. Signalperson should be approximately at final position as indicated in Figure A, when control of the aircraft is turned over to signalman #2.)

1. Raise arms to attract operator's attention (Figure 49)

FIGURE 49



2. Give signal to come ahead straight; and then give signals to turn the aircraft as required to keep the aircraft on course (Figures 50-55)

FIGURE 50



FIGURE 51



FIGURE 52



FIGURE 53



(Right Turn)

FIGURE 54



FIGURE 55



(Left Turn)

PROJECT GUIDE #2

3. Give signal to slow aircraft (Figures 56 and 57)

FIGURE 56



FIGURE 57



4. Give signal to stop and set brakes (Figures 58-59)

(NOTE: Have aircraft stop at point AA.)

FIGURE 58



FIGURE 59



PROJECT GUIDE #2

5. Give signal to turn over control of the aircraft to signalman #2
- G. Repeat procedures listed in step F, 1-5 with signalman #2 directing aircraft to point BB
- H. Signalman #2 then turns over control to a new signalman, replacing signalman #1; then repeat steps F through H until all students have performed as signalmen
- I. The final signalman turns over control to appropriate ground handler
- J. Ground handler will now give the signal to stop engine and install chocks (Figures 60-63)

FIGURE 60



FIGURE 61



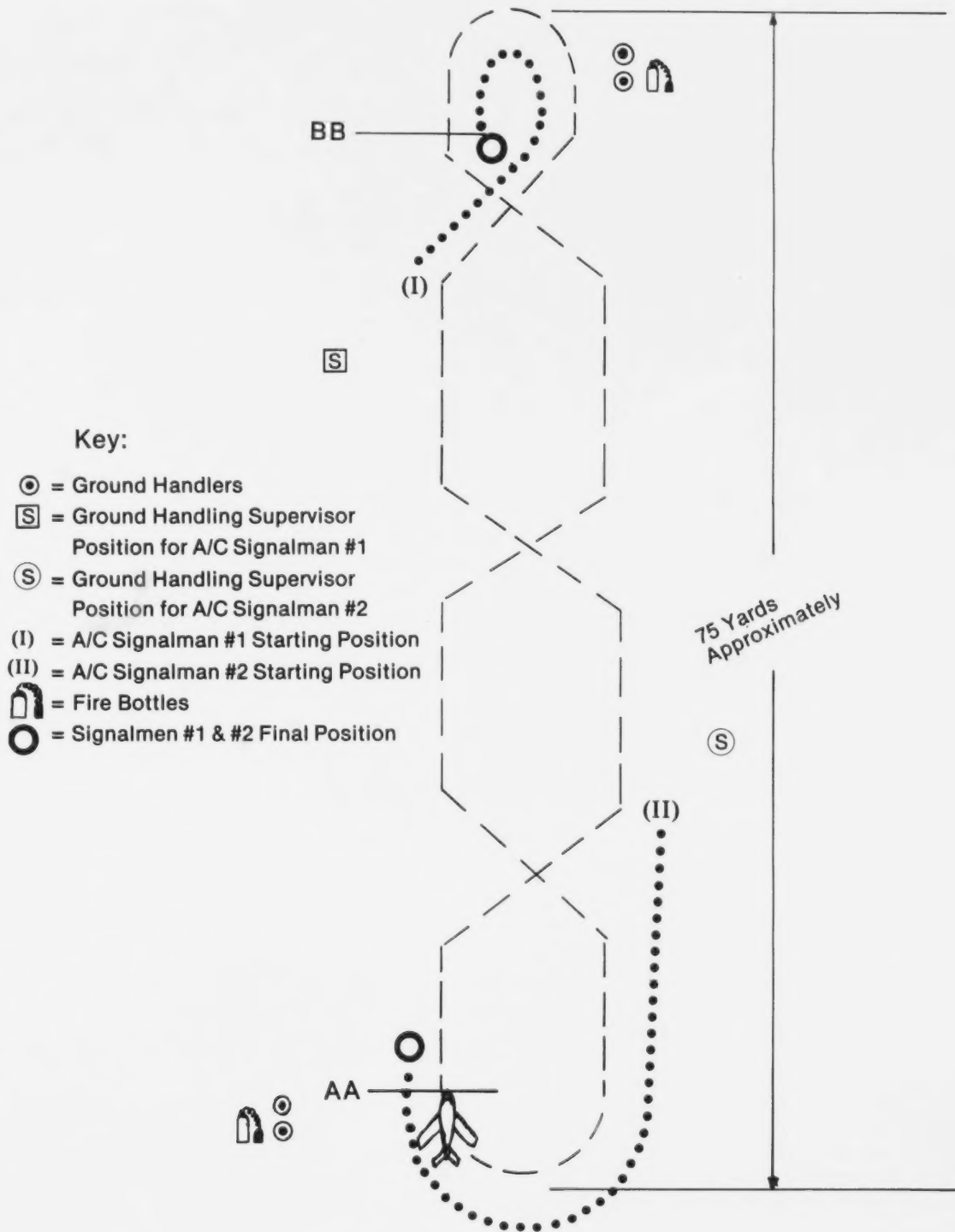
FIGURE 62



FIGURE 63



Figure A



GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

PROJECT GUIDE #3--Perform Reciprocating Engine Run-up

PURPOSE: This project is designed to prepare the student to perform procedures required to accomplish reciprocating engine maintenance run-up in a safe and professional manner.

(NOTE: This project guide must be performed with a minimum crew of four people.)

REFERENCE MANUALS:

- A. AC-65-9A 489-491
- B. Aircraft flight manual
- C. EA-ITP-G 7:25,26

EQUIPMENT AND TOOLS NEEDED:

- A. Cessna C-152 or similar aircraft
- B. CO₂ or halogenated hydrocarbon fire extinguisher, 10 lb. minimum
- C. Electrical auxiliary power unit
- D. Six stanchions, 4 feet in height
- E. 100 feet of 1/4-inch nylon rope

SUPPLIES AND MATERIALS:

- A. Pilot's information manual
- B. Manufacturer's maintenance
- C. Handouts of the starting procedures

PROCEDURE:

(NOTE: Engine run-up procedure used in this project is the procedure for a 1979 Cessna 152. For clarification some caution and procedure notes have been added and minor modifications have been made for maintenance run-up. If you wish to use any other aircraft, substitute the appropriate manufacturer's flight manual. The aircraft used in the project photographs is a Cessna 310 and was used solely to demonstrate how to establish a safety barrier and position personnel for engine run-up.)

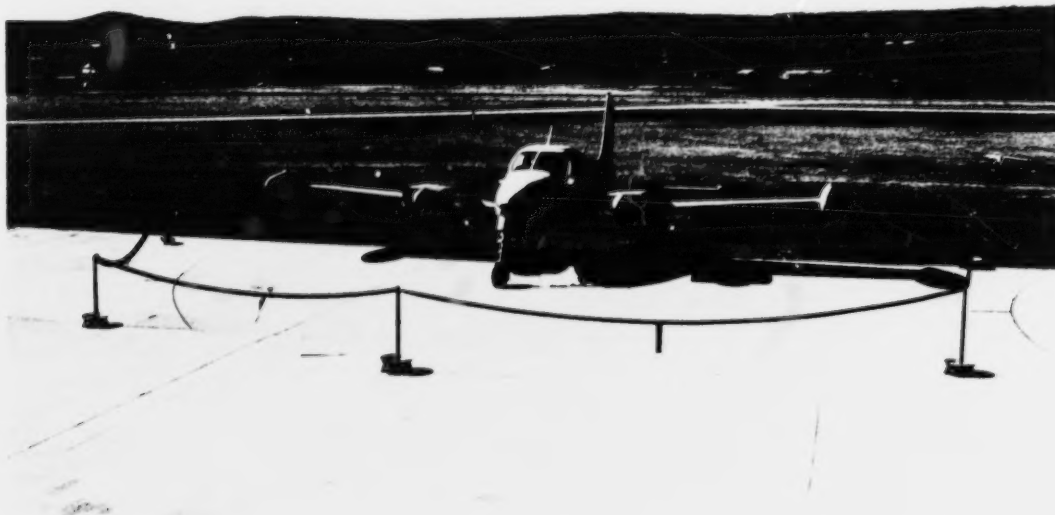
PROJECT GUIDE #3

- A. Position and secure the aircraft to head into the prevailing wind to insure adequate airflow over the engine for cooling purposes

(NOTE: Make sure that no property damage or personal injury will occur from the propeller or propeller blast.)

- B. Place stanchions and rope in a manner which will establish a safety zone in front of aircraft (Figure 64)

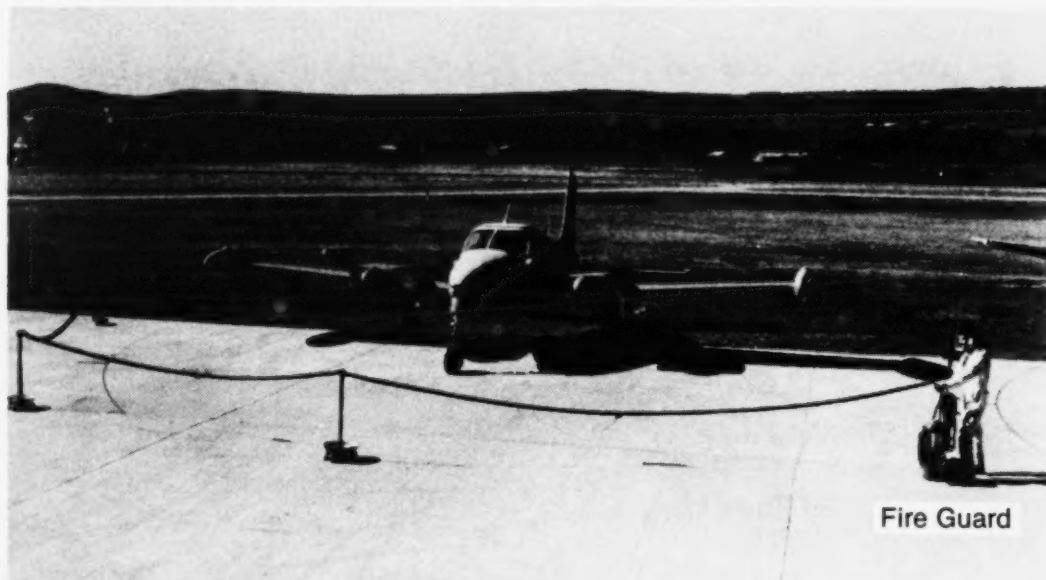
FIGURE 64



- C. Establish fire guard (Figure 65)

(NOTE: During any and all starting procedures, a "fire guard" equipped with a suitable fire extinguisher shall be stationed in an appropriate place. A fire guard is someone familiar with aircraft starting procedures. The fire extinguisher is a CO₂ extinguisher of not less than 10 lb. capacity. The appropriate place is adjacent to the outboard side of the engine, in view of the pilot, and also where the engine and aircraft can be observed for indication of starting problems. The fire guard should not leave this position during the run-up.)

FIGURE 65



- D. Have all personnel outside aircraft put on eye and ear protection
- E. Position safety/signalperson outside of safety zone and to right of aircraft (Figure 66)

FIGURE 66



- F. Position electrical auxiliary power unit operator at electrical power unit (Figure 67)

(NOTE: When external electrical power is used for starting, make sure that it can be removed safely.)

FIGURE 67



- G. Perform preflight inspection as outlined in the following preflight inspection procedures
- H. Perform run-up, consult and perform aircraft manufacturer's flight manual specific instructions
- (NOTE: Follow the procedures outlined on the following preflight inspection and run-up checklist procedures.)
- I. After all procedures are carried out, return equipment and materials to instructor

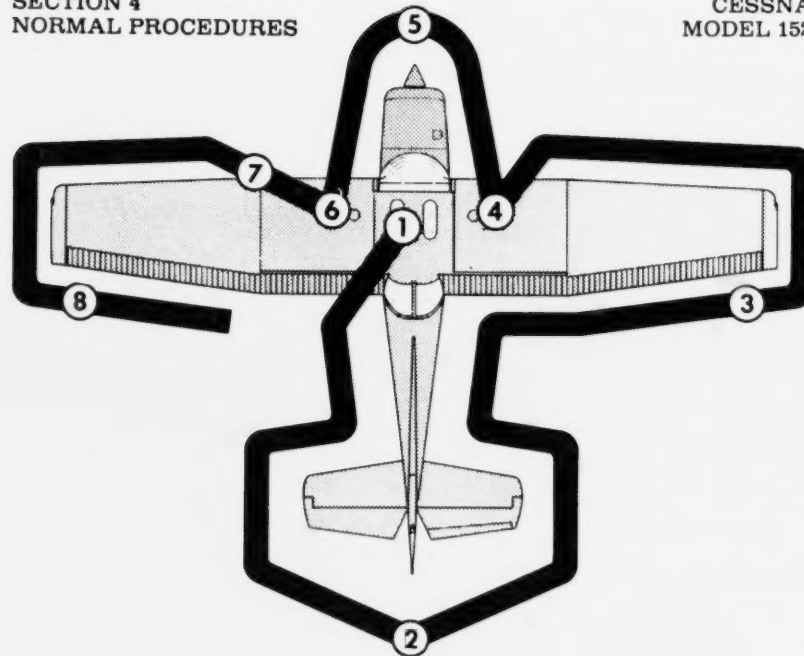
(Sample)

Preflight Inspection Procedure

FIGURE 68

SECTION 4 NORMAL PROCEDURES

CESSNA
MODEL 152



NOTE

Visually check airplane for general condition during walk-around inspection. In cold weather, remove even small accumulations of frost, ice or snow from wing, tail and control surfaces. Also, make sure that control surfaces contain no internal accumulations of ice or debris. Prior to flight, check that pitot heater (if installed) is warm to touch within 30 seconds with battery and pitot heat switches on. If a night flight is planned, check operation of all lights, and make sure a flashlight is available.

Figure 4-1. Preflight Inspection

4-4

1 July 1978

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(Sample)

CESSNA
MODEL 152SECTION 4
NORMAL PROCEDURES**CHECKLIST PROCEDURES****PREFLIGHT INSPECTION****① CABIN**

1. Pilot's Operating Handbook -- AVAILABLE IN THE AIRPLANE.
2. Control Wheel Lock -- REMOVE.
3. Ignition Switch -- OFF.
(Caution: Be sure to always check to make sure that ignition is off. Failure to do so could result in severe injury or possible death.)
4. Master Switch -- ON.

WARNING

When turning on the master switch, using an external power source, or pulling the propeller through by hand, treat the propeller as if the ignition switch were on. Do not stand, nor allow anyone else to stand, within the arc of the propeller, since a loose or broken wire, or a component malfunction, could cause the propeller to rotate.

5. Fuel Quantity Indicators -- CHECK QUANTITY.
(NOTE: This check is to determine the accuracy of the fuel quantity indicators. If a discrepancy exists, consult your instructor.)
6. Master Switch -- OFF.
7. Fuel Shutoff Valve -- ON.

② EMPENNAGE

1. Rudder Gust Lock -- REMOVE.
2. Tail Tie-Down -- CONNECT.
3. Control Surfaces -- CHECK freedom of movement and security.

③ RIGHT WING Trailing Edge

1. Aileron -- CHECK freedom of movement and security.

④ RIGHT WING

1. Wing Tie-Down -- DISCONNECT.
2. Main Wheel Tire -- CHECK for proper inflation.
3. Before starting, use sampler cup and drain small quantity of fuel from fuel tank sump quick-drain valve to check for water, sediment, and proper fuel grade.
4. Fuel Quantity -- CHECK VISUALLY for desired level.
5. Fuel Filler Cap -- SECURE.

1 July 1978

4-5

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(Sample)

SECTION 4
NORMAL PROCEDURESCESSNA
MODEL 152

⑤ NOSE

1. Engine Oil Level -- CHECK, do not operate with less than four quarts. Fill to six quarts for extended flight.
2. Before first flight of the day and after each refueling, pull out strainer drain knob for about four seconds to clear fuel strainer of possible water and sediment. Check strainer drain closed. If water is observed, the fuel system may contain additional water, and further draining of the system at the strainer, fuel tank sumps, and fuel line drain plug will be necessary.
3. Propeller and Spinner -- CHECK for nicks and security.
4. Carburetor Air Filter -- CHECK for restrictions by dust or other foreign matter.
5. Landing Light(s) -- CHECK for condition and cleanliness.
6. Nose Wheel Strut and Tire -- CHECK for proper inflation.
7. Nose Tie-Down -- CONNECT. (Make sure tie-down will not interfere with propeller movement.)
8. Static Source Opening (left side of fuselage) -- CHECK for stoppage.

⑥ LEFT WING

1. Main Wheel Tire -- CHECK for proper inflation.
2. Before first flight of day and after each refueling, use sampler cup and drain small quantity of fuel from fuel tank sump quick-drain valve to check for water, sediment and proper fuel grade.
3. Fuel Quantity -- CHECK VISUALLY for desired level.
4. Fuel Filler Cap -- SECURE.

⑦ LEFT WING Leading Edge

1. Pitot Tube Cover -- REMOVE and check opening for stoppage.
2. Stall Warning Opening -- CHECK for stoppage. To check the system, place a clean handkerchief over the vent opening and apply suction; a sound from the warning horn will confirm system operation.
3. Fuel Tank Vent Opening -- CHECK for stoppage.
4. Wing Tie-Down -- CONNECT.

⑧ LEFT WING Trailing Edge

1. Aileron -- CHECK freedom of movement and security.

BEFORE STARTING ENGINE

1. Preflight Inspection -- COMPLETE.
(Note: Crew Chief should now position himself in cockpit.)

4-6

1 July 1978

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(Sample)

CESSNA
MODEL 152SECTION 4
NORMAL PROCEDURES

2. Seats, Belts, Shoulder Harnesses -- ADJUST and LOCK.
3. Fuel Shutoff Valve -- ON.
4. Radios, Electrical Equipment -- OFF.
5. Brakes -- TEST and SET.
6. Circuit Breakers -- CHECK IN.

STARTING ENGINE (Temperatures Above Freezing)

NOTE Details concerning cold weather starting and operation at temperatures below freezing may be found under Cold Weather Operation paragraphs in this section.

1. Mixture -- RICH.
2. Carburetor Heat -- COLD.
3. Prime -- AS REQUIRED (up to 3 strokes).

NOTE

Weak intermittent firing followed by puffs of black smoke from the exhaust stack indicates overpriming or flooding. Excess fuel can be cleared from the combustion chambers by the following procedure: set the mixture control in the idle cut-off position, the throttle full open, and crank the engine through several revolutions with the starter. Repeat the starting procedure without any additional priming.

During engine starting, open the throttle approximately 1/2 inch. In warm weather, one stroke of the primer should be sufficient. In temperatures near freezing, up to 3 strokes of the primer may be necessary. As the engine starts, slowly adjust the throttle as required for 1000 RPM or less.

If the engine is underprimed (most likely in cold weather with a cold engine) it will not fire at all, and additional priming will be necessary.

4. Throttle -- OPEN 1/2 INCH.

The carburetor used on this airplane does not have an accelerator pump; therefore, pumping of the throttle must be avoided during starting because doing so will only cause excessive leaning.

5. Propeller Area -- CLEAR.
6. Master Switch -- ON.
7. Ignition Switch -- START (release when engine starts).
8. Throttle -- ADJUST for 1000 RPM or less.
9. Oil Pressure -- CHECK.

(NOTE: After starting, if the oil gage does not begin to show pressure within 30 seconds in the summertime and about twice that long in very cold weather, stop the engine and investigate. Lack of oil pressure can cause serious engine damage. After starting, avoid the use of carburetor heat unless icing conditions prevail)

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(Sample)

SECTION 4
NORMAL PROCEDURES

CESSNA
MODEL 152

SECURING AIRPLANE

(Note: Shut down engine according to manufacturer's instructions.)

1. Parking Brake -- SET.
2. Radios, Electrical Equipment -- OFF.
3. Mixture -- IDLE CUT-OFF (pull full out).
4. Ignition Switch -- OFF.
5. Master Switch -- OFF.
6. Control Lock -- INSTALL.

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GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

PROJECT GUIDE #4--Perform Aircraft Taxiing

PURPOSE: To prepare the student to perform the procedures used during aircraft taxiing and allow the student to develop skills necessary to control an aircraft that is in motion.

REFERENCE MANUAL: Applicable aircraft flight manual

EQUIPMENT AND TOOLS NEEDED:

- A. Light aircraft
- B. Suitable area for aircraft taxiing

PROCEDURE:

- A. Prepare aircraft according to manufacturer's instructions
(NOTE: Be sure to consult the preflight checklist.)
- B. Enter aircraft
(NOTE: Aircraft operator should occupy left seat.)
- C. Start engine using manufacturer's aircraft taxiing checklist
- D. Release brakes and taxi aircraft using rudder pedals to move nose gear
(NOTE: Differential braking may be used to make a sharper turn if required.)
- E. Establish proper control surface position during taxiing to maintain aircraft balance (See Figure 69)

PROJECT GUIDE #4

- F. Continue taxiing in accordance with your instructor's directions until you feel confident as sole manipulator of the aircraft's controls

(NOTE: When taxiing, it is important that speed and use of brakes be held to a minimum and that all controls be utilized to maintain directional control and balance. Refer to Figure 69 on the following page.)

(CAUTION: The carburetor heat control knob should be pushed full in during all ground operations unless heat is absolutely necessary. When the knob is pulled out to the heat position, air entering the engine is not filtered.)

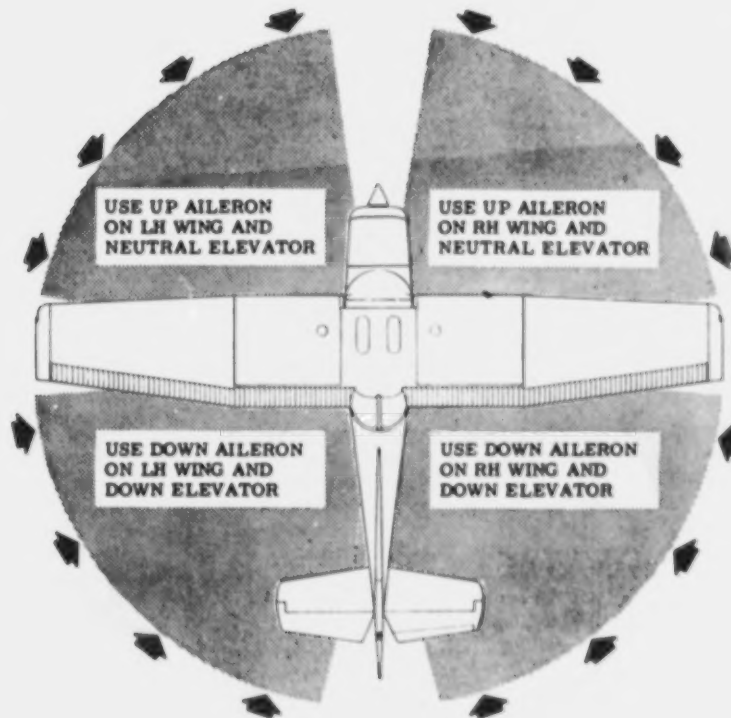
Taxiing over loose gravel or cinders should be done at low engine speed to avoid abrasion and stone damage to the propeller tips.)

(NOTE: The nose wheel is designed to automatically center straight ahead when the nose strut is fully extended. In the event the nose strut is overinflated and the airplane is loaded to a rearward center of gravity position, it may be necessary to partially compress the strut to permit steering. This can be accomplished prior to taxiing by depressing the airplane nose [by hand] or during taxi by sharply applying brakes.)

FIGURE 69

(Sample)

Aileron/Elevator Positioning and Wind Direction



CODE

WIND DIRECTION



NOTE

Strong quartering tail winds require caution. Avoid sudden bursts of the throttle and sharp braking when the airplane is in this altitude. Use the steerable nose wheel and rudder to maintain direction.

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GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

THEORY TEST

1. Match terms related to aircraft ground handling and servicing to their correct definitions. Write the correct numbers in the blanks.

- | | |
|---|--------------------------------|
| _____ a. Airplane whose wheels have been replaced with skis so it can be operated from snow or ice | 1. Windstorm |
| _____ b. Area of an airfield where airplanes are parked | 2. Thunderstorm |
| _____ c. Airplane designed to operate from surface of land rather than water or snow | 3. Spoiler |
| _____ d. Physiological point at which pain begins in the human body | 4. Flight line |
| _____ e. Internal engine damage which occurs from injection of foreign objects into the engine gas path | 5. Seaplane |
| _____ f. Storm characterized by high winds and little or no rain | 6. Ski plane |
| _____ g. Device used to spoil lift by disrupting airflow over an aerodynamic surface | 7. Foreign object damage (FOD) |
| _____ h. Usually a localized storm produced by a cumulonimbus cloud | 8. Threshold of pain |
| _____ i. Open-ended tube that faces directly into the relative airstream of an aircraft and picks up ram (pitot) pressure to be used in an airspeed indicator | 9. Pitot tube |
| _____ j. Special anchoring provision on an airport surface by which airplanes may be secured when they are parked | 10. Land plane |
| _____ k. Airplane designed to land and take off from the surface of water | 11. Tiedown |

THEORY TEST

- | | | | |
|----------|---|-----|----------------------------|
| _____ l. | Main spanwise structural member of a wing or other airfoil | 12. | Viscous |
| _____ m. | Power unit used to provide auxiliary air, hydraulic, and electrical power | 13. | Oleo strut |
| _____ n. | Ease with which fluids change from a liquid to a vapor | 14. | Spar |
| _____ o. | Aircraft landing gear shock strut that absorbs initial landing impact by transferring oil from one chamber to another through a restricting orifice | 15. | Static electricity |
| _____ p. | Hinged linkage between piston and cylinder of an oleo shock strut; allows piston to move in and out, but restrains it from rotating | 16. | Auxiliary power unit (APU) |
| _____ q. | Electrical charge which may be built by friction upon a nonconductive surface | 17. | Volatility |
| _____ r. | Wire or electrical connection used to ground a component or structure to an airframe | 18. | Torque links |
| _____ s. | Thick; having high resistance to flow | 19. | Bonding wire |

THEORY TEST

- | | | | |
|----------|---|-----|-----------------|
| _____ t. | Function of certain fuel additives which kill microbes and bacteria living in water in aircraft fuel tanks | 20. | Biocidal action |
| _____ u. | Form of heavier-than-air, rotor-wing aircraft whose lift is produced by engine-driven rotors, which are essentially long, narrow airfoils | 21. | Taxi |
| _____ v. | To move an airplane on the ground under its own power | 22. | Helicopter |
| _____ w. | To remove an undesirable constituent from a substance or region by physical or chemical means | 23. | Tow limit marks |
| _____ x. | Condition which occurs from an aircraft being ground handled in a rough and unprofessional manner | 24. | Amphibian |
| _____ y. | Marks on the aircraft's nose gear which show the maximum allowable travel off-center for the nose gear | 25. | Hangar rash |
| _____ z. | Aircraft designed to take off and land from either land or water | 26. | Scavenge |
2. State facts related to safety during aircraft ground handling and servicing. Write the correct answers in the blanks.
- a. What is the result of overloading extension cords or wall outlets?
- _____
- _____
- b. Why must compressed air never be used for dusting your skin?
- _____
- _____
- _____
- c. What is the result of allowing pure oxygen to come in contact with petroleum products?
- _____

THEORY TEST

- d. Why should all cutting and drilling tools be properly sharpened?

- e. What should be done if it is necessary to sweep spilled gasoline or dried paint overspray?

- f. List the three components of the fire triangle.

1) _____

2) _____

3) _____

- g. Match the classes of fires to their correct descriptions. Write the correct letters in the blanks.

_____ 1. Fire involving energized electrical equipment	a. Class A
_____ 2. Fire or solid combustible matter such as wood or paper	b. Class B
_____ 3. Fire involving combustible metals such as magnesium	c. Class C
_____ 4. Fire involving combustible liquids such as gasoline or oil	d. Class D

- h. State the two classes of fire on which a CO₂ fire extinguisher is used.

1) _____

2) _____

THEORY TEST

- i. List the three classes of fires on which dry-powder or dry chemical fire extinguishers are used.

1) _____
2) _____
3) _____

- j. Describe the symbol used to identify a fire extinguisher that is suitable for a Class C fire.

- k. Why is the area in front of an operating jet engine a danger area?

3. State facts related to aircraft tiedown procedures. Write the correct answers in the blanks.

- a. Why should control surfaces of an airplane that is subjected to a windstorm be secured with battens as well as having controls locked with built-in control locks?

- b. What should be done to the wings of an airplane to prevent them from producing lift when the airplane is being prepared for a severe windstorm?

- c. List the three types of ropes that can be used to tie down an aircraft.

1) _____
2) _____
3) _____

THEORY TEST

- d. List the locations of tiedown ropes to secure a nose-wheel type airplane before being subjected to high winds.

- 1) _____
2) _____
3) _____

4. Perform aircraft tiedown.

(NOTE: Test question 4 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

5. Select true statements related to aircraft jacking and hoisting. Circle the letter preceding each correct answer.

- a. A screw-type safety collar prevents an aircraft jack from retracting and lowering in the event that the jack leaks away the pressure
b. An aviation maintenance technician must be careful that the oleo struts depress smoothly when placing an aircraft on jacks

6. Select facts related to taxiing an aircraft. Circle the number preceding each correct answer.

- a. Which of the hand signals in the illustrations below would you give if a taxiing aircraft were in danger of striking an object?

- 1) C
2) A
3) B
4) D



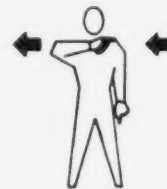
A



B



C



D

THEORY TEST

b. You are taxiing an aircraft on a runway at a controlled airport and you see a flashing red light directed at you from the control tower. What does the light mean?

- 1) OK to taxi on runway
- 2) Stop on runway
- 3) Taxi clear of runway
- 4) Return to place you started from

7. Identify standard FAA hand signals used for ground handling fixed-wing and helicopter-type aircraft. Write the correct answers in the blanks.



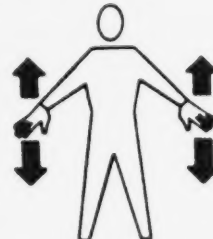
a. _____



b. _____



c. _____



d. _____



e. _____

THEORY TEST

(NOTE: Test question 8 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

9. Select statements related to the towing of aircraft. Circle the number preceding each correct answer.
- a. When towing an aircraft
 - 1) Discharge all hydraulic pressure to prevent accidental operation of the landing gear retracting mechanism
 - 2) Tow all tailwheel aircraft backwards
 - 3) If the aircraft has a steerable nosewheel, set the locking scissors to full swivel
 - 4) Tow all nosewheel aircraft backwards
 - b. When towing an aircraft, the maximum speed for safe towing is
 - 1) Walking speed
 - 2) 15 mph
 - 3) 20 mph
 - 4) 10 mph
10. State facts related to aircraft servicing and ground support equipment. Write the correct answers in the blanks.
- a. What will be the effect on an airplane of improper polarity from an auxiliary power cart to which it is connected?

 - b. When an aircraft oxygen system is serviced from a charging cart having several oxygen cylinders, which cylinder should be used first: the one having the highest pressure, or the one having the lowest pressure? _____
11. Identify the following aircraft fuels.
- a. Write the correct color of these fuels in the blanks.
 - 1) 80 grade-- _____
 - 2) 100 low lead-- _____
 - 3) 100 grade-- _____
 - 4) 115/145 grade-- _____

THEORY TEST

- b. Which aircraft fuel is a blend of both gasoline and kerosene fractions? _____
12. State facts related to fire hazards involving aircraft fuels. Write the correct answers in the blanks.
- a. What is the proper way to prevent spilled aviation gasoline that is causing a major fire hazard?
- _____
- _____
- b. What must be done when fueling an aircraft to prevent a charge of static electricity that would cause a spark and a fire?
- _____
- _____
13. List the three contaminants which commonly occur in aircraft fuels.
- a. _____
- b. _____
- c. _____
14. Select statements related to aircraft fuels, fueling, and defueling procedures. Circle the number preceding each correct answer.
- a. What would be the action to take if aviation gasoline in an aircraft was contaminated with jet fuel?
- 1) Determine the type of jet fuel, then contact the engine manufacturer for guidance
- 2) Adjust mixture to compensate for lower octane
- 3) Determine the amount of fuel that was put in tanks and if under 25 percent of total volume, do nothing; if over 25 percent, drain the tanks and refill
- 4) Drain fuel tanks and fill with proper octane rating fuel

THEORY TEST

- b. Aviation gasoline mixed with jet fuel will have which of the following effects on turbine powerplant efficiency?
- 1) No disadvantages
 - 2) Tetraethyl lead in the gasoline forms deposits on turbine blades
 - 3) Tetraethyl lead in the gasoline forms deposits on the compressor blades
 - 4) Continuous use will not affect engine efficiency
- c. How are aviation fuels which possess greater antiknock qualities than 100 octane classified?
- 1) As antidetonants
 - 2) According to the milliliters of lead
 - 3) By reference to normal heptane
 - 4) By performance numbers
- d. Why is ethylene dibromide added to all grades of aviation gasoline?
- 1) To prevent detonation at takeoff power settings
 - 2) To remove zinc silicate deposits from the spark plugs
 - 3) To scavenge lead oxide from the cylinder combustion chambers
 - 4) To increase the antiknock rating of the fuel
- e. Both gasoline and kerosene have certain advantages for use as a turbine fuel. Which of the following is a true statement in reference to the advantages of each?
- 1) Kerosene has a higher heat energy per unit weight than gasoline
 - 2) Gasoline is a better lubricant than kerosene; this is important in regard to fuel metering pumps
 - 3) Gasoline has a higher heat energy per unit volume than kerosene
 - 4) Kerosene has a higher heat energy per unit volume than gasoline

THEORY TEST

- f. What will fuel that does not vaporize readily enough cause?
- 1) Vapor lock
 - 2) Detonation
 - 3) Hard starting
 - 4) Surface ignition
- g. What are fuel number identifiers?
- 1) Performance numbers to designate the volatility of the fuel
 - 2) Performance numbers and are relative to the fuel's performance in the aircraft engine
 - 3) Type numbers and they have no relation to the fuel's performance in the aircraft engine
 - 4) Type numbers used to designate the vaporization rate at atmospheric pressure
- h. What is the second number in a fuel rating (100/130)?
- 1) Lean mixture antiknock rating
 - 2) Percent of iso-octane in the fuel
 - 3) Percent of normal heptane in the fuel
 - 4) Rich mixture antiknock rating
- i. What characteristic of a fuel reduces its tendency to vapor lock?
- 1) Low latent heat of vaporization
 - 2) High volatility
 - 3) Low vapor pressure
 - 4) High octane rating or performance number
- j. Which of the following is a characteristic of aviation gasoline?
- 1) High heat value, high volatility
 - 2) High heat value, low volatility
 - 3) Low heat value, high volatility
 - 4) Low heat value, low volatility

THEORY TEST

15. Select true statements related to safety when fueling or defueling aircraft. Circle the letter preceding each correct answer.
- a. Be sure that fuel tank or servicer is properly bonded to aircraft and fuel nozzle is bonded to structure after cover is taken from fuel tank
 - b. Wipe up spilled fuel with absorbent material or blanket with foam and then flood with water
 - c. Do not sweep spilled fuel with a dry broom
 - d. Be sure that filters in tank truck remove all traces of water and contamination and that fuel pumped into aircraft is bright and clear
 - e. Be sure that there are no open fires in the vicinity of the fueling or defueling operation
16. Select statements related to engine run-up procedures. Circle the number preceding each correct answer.
- a. Starting a reciprocating engine which has a liquid lock in one of the cylinders could cause
 - 1) Compressive failure of the valve bodies
 - 2) Major structural damage
 - 3) Removal of the lubricating film on the cylinder walls
 - 4) Starter clutch damage
 - b. When starting an aircraft engine equipped with a float-type carburetor, air-heat control should be placed in
 - 1) The COLD position
 - 2) The COLD position under nonicing conditions and in the HOT position under icing conditions
 - 3) The HOT position to reduce the engine warmup period
 - 4) A position between HOT and COLD
 - c. The priming of a fuel-injected horizontally opposed engine is accomplished by placing the fuel control lever in which of the following positions?
 - 1) Auto-Lean position
 - 2) Idle-Cutoff position

THEORY TEST

- 3) Auto-Rich position
 - 4) Full-Rich position
- d. How is a flooded engine, equipped with a float-type carburetor, cleared of excessive fuel?
- 1) Crank the engine with the starter or by hand, with the mixture control in cutoff, ignition switch off, and the throttle fully open, until the fuel charge has been cleared
 - 2) Crank the engine with the starter or by hand, with the mixture control in cutoff, ignition switch off, and the throttle closed, until the fuel has been cleared
 - 3) Turn off the fuel and the ignition; discontinue the starting attempt until the excess fuel has cleared
 - 4) Crank the engine with the starter or by hand, with the mixture control in cutoff, ignition switch on, and the throttle fully open, until the excess fuel has cleared or until the engine starts
- e. Which action would be required if the turbine inlet temperature exceeds the specified maximum during the starting sequence of a turboprop engine?
- 1) Advance the power lever and observe for excessive smoke; if present, discontinue the start
 - 2) Turn off the fuel and ignition switch, discontinue the start, and make the investigation
 - 3) Continue the start since temperature will stabilize as soon as 5,000 rpm is reached
 - 4) Turn off the fuel and ignition switch, discontinue the start, then wait 5 minutes and initiate the starting sequence
- f. During starting of a turbojet powerplant using a compressed air starter, a hung start occurred. What is the proper procedure?
- 1) Advance the power lever
 - 2) Increase airpower to the starter
 - 3) Re-engage the starter
 - 4) Shut the engine down

THEORY TEST

- g. During starting of a turbojet powerplant using compressed air starter, a hot start occurrence was recorded. What happened?
- 1) Pneumatic starting unit overheated
 - 2) Fuel/air mixture was excessively rich
 - 3) Powerplant was preheated before starting
 - 4) Pneumatic starter overheated
- h. When starting an engine equipped with a float-type carburetor with an idle cutoff unit, the mechanic should place the mixture control in the
- 1) Idle-Cutoff position
 - 2) Full-Lean position
 - 3) Full-Rich position while priming the engine; however, the mixture control should be returned to the Idle-Cutoff position when actually starting the engine.
 - 4) Full-Rich position
- i. Induction fires during starting can be extinguished by
- 1) Directing carbon dioxide into the air intake of the engine
 - 2) Directing carbon dioxide into the exhaust system
 - 3) Closing the fuel shutoff valve
 - 4) Closing the throttle
- j. If fuel flows steadily from the internal supercharger drain valve during an attempt to start an engine, which of the following is a possible cause of the trouble?
- 1) Excessive booster pump pressure
 - 2) Fuel pump relief valve is out of adjustment
 - 3) An improper setting of the mixture control
 - 4) A fatigued carburetor fuel supply line

THEORY TEST

- k. During the starting sequence of a turboprop engine, there is no oil pressure indication at 5,000 rpm for either the reduction gear or the power unit. What action is required?
- 1) Turn off the ignition switch and fuel, discontinue the start, and release the oil pressure gage
 - 2) Turn off the ignition switch and fuel, let the engine motorize for 5 minutes, and restart
 - 3) Turn off the ignition switch and fuel, discontinue the start, and make an investigation
 - 4) Turn off the ignition switch and fuel, discontinue the start, wait for 5 minutes, and initiate the starting sequence
1. Which of the following indicators should be checked immediately after starting a reciprocating engine?
- 1) Oil pressure
 - 2) Manifold pressure
 - 3) Tachometer
 - 4) Cylinder head temperature

(NOTE: Test questions 17 and 18 are project guides. They are an important part of this test. If they have not been completed, check with your instructor.)

17. Perform reciprocating engine run-up.
18. Perform aircraft taxiing.

GENERAL
G104 TECHNICAL MECHANICS
PERFORM AIRCRAFT GROUND HANDLING AND SERVICING
G104-A

ANSWERS TO THEORY TEST

1. a.	6	1. 14	w. 26
b.	4	m. 16	x. 25
c.	10	n. 17	y. 23
d.	8	o. 13	z. 24
e.	7	p. 18	
f.	1	q. 15	
g.	3	r. 19	
h.	2	s. 12	
i.	9	t. 20	
j.	11	u. 22	
k.	5	v. 21	

2. a. Contacts will carry more current than they were designed and rated to carry, resulting in overheating and fire
- b. The concentrated stream of compressed air could cause air to enter your bloodstream causing severe injury
- c. Extremely rapid spontaneous combustion
- d. Dull or improperly sharpened tools can require excessive force to be used resulting in work being grabbed or thrown out of the machine
- e. Flush these combustible products with water before sweeping
- f. 1) Fuel
2) Oxygen
3) Heat
- g. 1) c
2) a
3) d
4) b
- h. 1) Class B
2) Class C
- i. 1) Class B
2) Class C
3) Class D
- j. A blue circle with the letter C inside it

ANSWERS TO THEORY TEST

- k. Low pressure generated by air flowing into the jet engine can pull objects or people into the engine
- 3. a. Forced movement of the surface by wind can damage the control actuating system
- b. Spoiler boards should be lashed to the top of the wing surface to kill lift produced by wind blowing over the surface
- c. 1) Nylon
2) Dacron
3) Yellow polypropylene
- d. 1) Nose gear
2) One at each wing tiedown point
3) Two at the tail tiedown point
- 4. Performance skills evaluated to the satisfaction of the instructor
- 5. a
- 6. a. 1
b. 3
- 7. a. All clear (OK)
b. Stop
c. Pull chocks
d. Slow down
e. Engage rotor
- 8. Performance skills evaluated to the satisfaction of the instructor
- 9. a. 3
b. 1
- 10. a. Damage to the alternator or the battery in the aircraft
b. The cylinder having the lowest pressure
- 11. a. 1) Red
2) Blue
3) Green
4) Purple

ANSWERS TO THEORY TEST

- b. Jet B
12. a. Blanket with foam and wash away with large amounts of water as soon as possible following local and federal pollution procedures
b. The aircraft and the fuel truck must be bonded together and both connected to the earth ground
13. a. Water
b. Solids
c. Microbial growths
14. a. 4 f. 3
b. 2 g. 3
c. 4 h. 4
d. 3 i. 3
e. 4 j. 1
15. a, b, c, d, e
16. a. 2 g. 2
b. 1 h. 4
c. 4 i. 1
d. 1 j. 3
e. 2 k. 3
f. 4 l. 1
17. Performance skills evaluated to the satisfaction of the instructor
18. Performance skills evaluated to the satisfaction of the instructor

MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

MODULE CONTENTS

- A. Introduction and Module Objective
- B. Specific Objectives
- C. Instructor's Module Implementation Guide
- D. Technical Information Supplements
 - 1. Technical Information Supplement #1--Guidelines for Care and Safe Use of Hand Tools
 - 2. Technical Information Supplement #2--Using a Rule
 - 3. Technical Information Supplement #3--Drill Press Safety Precautions and Parts
 - 4. Technical Information Supplement #4--Bench Grinder Safety Precautions and Parts
 - 5. Technical Information Supplement #5--Band Saw Safety Precautions and Parts
 - 6. Technical Information Supplement #6--Pneumatic Portable Power Drill Safety Precautions
- E. Transparency Masters
 - 1. TM #1--Types of Hammers
 - 2. TM #2--Types of Punches
 - 3. TM #3--Types of Pliers
 - 4. TM #4--Types of Chisels Used by the Aviation Technician
 - 5. TM #5--Types of Files
 - 6. TM #6--Parts of a File, Cuts, and File Card
 - 7. TM #7--Types of Shears
 - 8. TM #8--Types of Hand Saws
 - 9. TM #9--Types of Wood-Boring Bits
 - 10. TM #10--Parts of a Twist Drill

MODULE CONTENTS

11. TM #11--Types of Reamers
12. TM #12--Types of Hand Taps
13. TM #13--Types of Dies Most Often Used by the Aviation Maintenance Technician
14. TM #14--Types of Screwdrivers
15. TM #15--Types of Wrenches
16. TM #16--Types of Sockets
17. TM #17--Types of Drivers
18. TM #18--Three Basic Types of Torque Wrenches
19. TM #19--Parts of a Combination Set
20. TM #20--Units of Measurement
21. TM #21--Eighths Graduations
22. TM #22--Sixteenths Graduations
23. TM #23--Thirty-Seconds Graduations
24. TM #24--Sixty-Fourths Graduations
25. TM #25--Dividers and Calipers
26. TM #26--Parts of a Micrometer
27. TM #27--Selecting the Proper Size Micrometer
28. TM #28--Checking the Micrometer for Accuracy
29. TM #29--Reading a Micrometer
30. TM #30--Micrometer Sleeve Readings
31. TM #31--Vernier Micrometer Readings
32. TM #32--Parts of the Inside Micrometer
33. TM #33--Uses of the Inside Micrometer
34. TM #34--Uses of the Inside Micrometer (Continued)
35. TM #35--Inside Micrometer Set

MODULE CONTENTS

36. TM #36--Inside Micrometer Set (Continued)
 37. TM #37--Methods of Checking Inside Micrometers for Accuracy
 38. TM #38--Parts of a Depth Micrometer
 39. TM #39--Uses of the Depth Micrometer
 40. TM #40--Types of Extension Rods
 41. TM #41--Preparing the Depth Micrometer and Workpiece for Measurement
 42. TM #42--Reading the Depth Micrometer
 43. TM #43--Depth Micrometer Readings
 44. TM #44--Depth Micrometer Sleeve Readings
 45. TM #45--Parts of a Drill Press
 46. TM #46--Parts of a Bench Grinder
 47. TM #47--Parts of a Band Saw
- F. Workbook Supplements
1. Workbook Supplement #1--Determine Tap and Body Drill Sizes
 2. Workbook Supplement #2--Interpret the National Taper Pipe Thread Size Chart
 3. Workbook Supplement #3--Use a Rule
 4. Workbook Supplement #4--Read Micrometer Settings
- G. Answers to Workbook Supplements
- H. Project Guides
1. Project Guide #1--Use the Micrometer Caliper
 2. Project Guide #2--Use the Inside Micrometer
 3. Project Guide #3--Use the Depth Micrometer
 4. Project Guide #4--Use Vernier Caliper to Take Inside, Outside, and Depth Measurements
 5. Project Guide #5--Use Hand and Power Tools

MODULE CONTENTS

I. Theory Test

J. Answers to Theory Test

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

INTRODUCTION

Aviation maintenance is totally dependent on the use of tools. As an aviation maintenance technician you will have a sizeable investment in your tools. Therefore it is necessary that you know how to use your tools safely and correctly.

MODULE OBJECTIVE

After completion of this module, you will be able to identify and safely use hand and power tools and precision measuring instruments. You will demonstrate this knowledge by completing the procedures outlined in the workbook assignments and project guides. You will further demonstrate this knowledge by scoring a minimum of 85 percent on the module theory test.

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

SPECIFIC OBJECTIVES

After completion of this module you will be able to:

- | | Technical Supplement #1 | |
|--|-------------------------|--------------------------|
| 1. State guidelines for care and and safe use of hand tools. (1) | | |
| 2. Identify types of hammers. (2) | EA-ITP-G
EA-ITP-GW | 5:II:37-39
5:II:11 |
| 3. Match types of hammers to their correct uses. (1) | EA-ITP-G | 5:II:37-39 |
| 4. Identify types of punches. (2) | EA-ITP-G
EA-ITP-GW | 5:II:39-41
5:II:11 |
| 5. Match types of punches to their correct uses. (1) | EA-ITP-G
EA-ITP-GW | 5:II:39-41
5:II:11 |
| 6. Identify types of pliers. (2) | EA-ITP-G | 5:II:41-43 |
| 7. Match types of pliers to their correct uses. (1) | EA-ITP-G | 5:II:41-43 |
| 8. Identify types of chisels most often used by the aviation technician. (1) | EA-ITP-G | 5:II:43-44 |
| 9. Match types of chisels to their correct uses. (2) | EA-ITP-G | 5:II:43-44 |
| 10. Identify types of files. (2) | EA-ITP-G | 5:II:44-45 |
| 11. Match types of files to their correct uses. (1) | EA-ITP-G | 5:II:44-45 |
| 12. Label the parts of a file. (1) | EA-ITP-G | 5:II:45 |
| 13. Select true statements related to the cut and proper usage of files. (1) | EA-ITP-G
EA-ITP-GW | 5:II:46-47
5:II:11-12 |
| 14. Identify types of shears. (2) | EA-ITP-G | 5:II:47 |

SPECIFIC OBJECTIVES

15.	Identify types of saws. (2)	EA-ITP-G	5:II:48-49
16.	Match types of saws to their correct uses. (1)	EA-ITP-G	5:II:48-49
17.	Select true statements related to the construction of saws. (1)	EA-ITP-G EA:ITP:GW	5:II:48-49 5:II:12
18.	List the two types of bits used for boring holes in wood. (1)	EA-ITP-G	5:II:49
19.	Label the parts of a twist drill. (2)	EA-ITP-G	5:II:51
20.	Select true statements related to sizes, points, and uses of twist drills.	EA-ITP-G EA-ITP-GW AC 65-9A	5:II:51-52 5:II:12-13 539
21.	Identify types of hole cutters. (2)	EA-ITP-G	5:II:53-54
22.	Identify types of reamers. (2)	EA-ITP-G	5:II:54
23.	State the purpose of taps. (1)	EA-ITP-G	5:II:54
24.	Match descriptions of types of thread fits to their correct classes. (1)	EA-ITP-G	5:II:54-56
25.	Determine tap and body drill sizes. (2)	EA-ITP-G EA-ITP-GW Workbook Supplement #1	5:II:55 5:II:14-15
26.	Identify types of hand taps. (2)	EA-ITP-G	5:II:56
27.	Interpret the National Taper Pipe Thread Size Chart. (2)	EA-ITP-G EA-ITP-GW Workbook Supplement #2	5:II:56 5:II:15
28.	State the purpose of dies. (1)	EA-ITP-G	5:II:56
29.	List types of dies most often used by the aviation maintenance technician. (1)	EA-ITP-G	5:II:57
30.	Identify types of screwdrivers. (2)	EA-ITP-G	5:II:57-59
31.	Identify types of wrenches. (2)	EA-ITP-G	5:II:60-61

SPECIFIC OBJECTIVES

32.	Identify types of sockets. (2)	EA-ITP-G	5:II:61-62
33.	Describe how to use a hand impact tool. (2)	EA-ITP-G	5:II:64
34.	Explain the disadvantage of an impact wrench. (1)	EA-ITP-G	5:II:64
35.	Identify basic types of torque wrenches most used in aviation maintenance. (2)	EA-ITP-G	5:II:64-67
36.	Name units of measure to which torque wrenches are calibrated. (1)	EA-ITP-G EA-ITP-GW	5:II:65 5:II:16
37.	State the formula used to determine the amount of torque to be used when an adapter is added to the torque wrench. (1)	EA-ITP-G	5:II:65
38.	Determine the force to be applied to the fastener by a torque wrench. (3)	EA-ITP-G EA-ITP-GW	5:II:65-67 5:II:16-17
39.	Select true statements related to the uses of torque wrenches. (1)	EA-ITP-G	5:II:68
40.	Label the parts of a combination set. (2)	EA-ITP-G	5:II:70
41.	Use a rule. (3)	Technical Supplement #2 Workbook Supplement #3	
42.	Identify dividers and types of calipers. (2)	EA-ITP-G	5:II:70-71
43.	Match dividers and types of calipers to the correct procedures for their uses. (1)	EA-ITP-G	5:II:70-72
44.	State the purpose of the micrometer caliper. (1)	EA-ITP-G	5:II:72
45.	Label the parts of a micrometer caliper. (2)	Transparency Master #25	
46.	Interpret drawings of micrometer readings. (2)	EA-ITP-G EA-ITP-GW Workbook Supplement #4	5:II:72-74 5:II:17-19

SPECIFIC OBJECTIVES

47.	State the purpose of vernier micrometer calipers. (1)	EA-ITP-G EA-ITP-GW	5:II:74 5:II:20-21
48.	Explain the process of using an inside micrometer. (1)	EA-ITP-G	5:II:74
49.	Explain the process for using a micrometer depth gage. (1)	EA-ITP-G	5:II:75
50.	Explain the process for using vernier calipers. (1)	EA-ITP-G EA-ITP-GW	5:II:76-77 5:II:22-23
51.	Use the micrometer caliper. (3)	Project Guide #1	
52.	Use the inside micrometer. (3)	Project Guide #2	
53.	Use the depth micrometer. (3)	Project Guide #3	
54.	Use vernier caliper to take inside, outside, and depth measurements. (3)	Project Guide #4	
55.	List uses of a drill press. (1)	Technical Supplement #3	
56.	State rules for safe use of drill presses. (1)	Technical Supplement #3	
57.	Label the parts of a drill press.	Technical Supplement #3	
58.	State rules for safe use of bench grinders. (1)	Technical Supplement #4	
59.	Label the parts of a bench grinder. (2)	Technical Supplement #4	
60.	State rules for safe use of band saws. (1)	Technical Supplement #5	
61.	Label the parts of a band saw. (2)	Technical Supplement #5	
62.	State rules for safe use of pneumatic portable power drills. (1)	Technical Supplement #6	
63.	Use hand and power tools. (3)	Project Guide #5	

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module

A. Videotapes

1. The Mechanic's Tool Box, ITP-G5, Program 2
2. Measuring and Layout Tools, ITP-G5, Program 3
3. Precision Measuring Instruments, The Micrometer Caliper,
ITPS-119
4. Precision Measuring Instruments, The Vernier Caliper,
ITPS-120

(NOTE: These videotapes are available from Aviation Maintenance Publishers, P.O. Box 36, 1000 College View Drive, Riverton, Wyoming 82501.)

B. Slides

1. Hand Tools

(NOTE: These slides are available from the National Safety Council, 444 North Michigan Avenue, Chicago, Illinois 60611.)

2. Torque Wrenches

(NOTE: These slides are available from Hobar Publications, 1305 Tiller Lane, St. Paul, Minnesota 55112.)

3. Micrometer Instruments

(NOTE: These slides are available from Industrial Training, Inc. 2023 Eastern Avenue, SE, P.O. Box 7186, Grand Rapids, Michigan 49510.)

C. Books

1. Micrometers, Calipers, and Gages

2. Torque and Torque Wrenches

(NOTE: These books are available from Hobar Publications, 1234 Tiller Lane, St. Paul, Minnesota 55112.)

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

II. Implementation Suggestions

(NOTE: Due to the amount of material to be covered in this module, it is suggested that the Theory Test be given in three parts. Give part one upon the completion of hand tools, part two upon the completion of precision measuring devices, and part three upon the completion of power tools. Have students read material related to the specific objectives. Workbook supplements may be completed as homework assignments.)

Estimated Teaching Time		Theory	Lab
Objective 1	Discuss guidelines for care and safe use of hand tools. Review Technical Information Supplement #1 and show videotape, <u>The Mechanic's Tool Box</u> ; ITP-G2, Program 2, and the slide presentation <u>Hand Tools</u> .		
Objectives 2-3	Discuss the fact that pounding tools are used for a variety of functions and that the selection of the correct hammer for a specific job is the responsibility of the technician. Demonstrate the use of each hammer individually and allow students to handle each one. Be sure to include dead blow hammers and plastic, rubber, and rawhide mallets in discussion. Use Transparency Master #1.		
Objectives 4-5	Display types of punches and demonstrate their proper use and handling. Be sure to explain that some punches are called by more than one name, for example, starting or drift punch. Use Transparency Master #2.		
Objectives 6-7	Demonstrate the use of various types of gripping and cutting pliers and illustrate the importance of selecting the proper tool for a specific job. Drill students on the correct use of each. Use Transparency Master #3.		

INSTRUCTORS'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objectives 8-9	Chisels are a type of cutting tool and can be used for a variety of applications. Demonstrate the use of each type of chisel. Include, if possible, an example of pneumatic power chisel holder. Use Transparency Master #4.	
Objectives 10-13	A file is also a form of cutting tool and is used for removing material in a variety of situations. Files are alike in many ways, but the specific shape should be stressed in the process of selecting the right tool for a specific job. Use Transparency Masters #5-#6. Have students complete EA-ITP-GW 5:II:11-12.	
Objective 14	Shears are unique cutting tools that must be demonstrated in order to show the correct method for cutting various types of metal. Be sure to include nibblers in demonstration. Use Transparency Master #7.	
Objectives 15-17	Compare the size and shape of teeth of various types of saws used in the aviation industry. Stress the importance of proper care and handling of each saw. Demonstrate their proper use and handling. Explain the use of coping saws. Use Transparency Master #8.	
Objectives 18-20	Demonstrate the use of the major types of bits and twist drills. Include in your demonstration a multi-cut bit (uni-bit). Have students make correction in ITP textbook regarding fractional sizes of twist drills. Fractional sizes range from 1/64 to 3 1/2 inches. Have students complete EA-ITP-GW 5:II:12-13. Use Transparency Masters #9-#10.	
Objectives 21-22	Compare the function of hole cutters and reamers as they relate to the removal of metal from machined parts. Use Transparency Master #11.	

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objectives 23-27	Discuss the difference between drills and taps, and illustrate the difference in tools that are used to accomplish specific tasks. Use the body and drill chart in EA-ITP-G 5:II:55 to compare sizes. Have students complete Workbook Supplement #1 and EA-ITP-GW 5:II:14-15. Demonstrate correct tapping and threading procedure using the tools discussed in EA-ITP-G 5:II:54-56. Explain the difference between thread forms, types of fits, and whether they are tapered or straight. Use Transparency Master #12. Have students complete Workbook Supplement #2.	
Objectives 28-29	Review EA-ITP-G 5:II:56-57 to explain the difference between taps and dies. Discuss the importance of fits. Emphasize the importance of threads and fasteners to the aviation industry. Use Transparency Master #13.	
Objective 30	Discuss the importance of proper care and use of screwdrivers as well as the selection of the proper screwdrivers for a specific job. Use Transparency Master #14.	
Objective 31	Display a variety of end wrenches and demonstrate key points for their proper use. Compare the application for various types of end wrenches. Use Transparency Master #15.	
Objective 32	Discuss the importance of being able to select and connect various types of sockets and socket attachments to accomplish a variety of tasks. Explain the importance of quality and precision in the selection of specific tools. Use Transparency Master #16.	
Objectives 33-34	Demonstrate the use of hand impact tools and compare their functions to the other types of wrenches and tools. Discuss the advantages and disadvantages of hand impact tools.	

INSTRUCTORS'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objectives 35-39	Discuss the various types of torque wrenches and the units of measure to which they are calibrated. Allow students to handle each tool with specific caution about the amount of force to be applied. Have students complete EA-ITP-GW 5:II:16-17. Use Transparency Master #17. Show slide presentation <u>Torque Wrenches</u> .	
Objectives 40-41	Show videotape, <u>Measuring Layout Tools</u> , ITP-G5, Program 3. Use this as a discussion topic for the area of measuring devices such as the combination set, the caliper, and micrometer. Explain that the ability to read any of these instruments is dependent upon the ability to read a rule. Have students read Technical Information Supplement #2 and complete Workbook Supplement #3. Use Transparency Masters #18-#23.	
Objectives 42-43	Have students review EA-ITP-G 5:II:70-72 before discussing the function and types of dividers and calipers. Use Transparency Master #24.	
Objectives 44-50	This particular area has several transparency masters that adequately describe the importance, function, and proper use of micrometers. As each of the objectives related to micrometers is discussed, refer to EA-ITP-G 5:II:72-77. Use Transparency Masters #25-#42. Have students complete Workbook Supplement #4 and EA-ITP-GW 5:II:17-23. Show videotapes, <u>Precision Measuring Instruments, The Micrometer Caliper</u> , ITPS-119, after Objective 45 and <u>Precision Measuring Instruments, The Vernier Caliper</u> , ITP-120, after Objective 50. Show slide presentations in <u>Micrometer Instruments</u> after each appropriate objective.	

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objectives 51-54	Have students complete Project Guides #1-#4.	
Objectives 55-57	Review Technical Information Supplement #3 and Transparency Master #43 to explain the parts and proper use of the drill press. Take students to the drill press and discuss key points of operation. Students should watch instructor demonstrate proper start-up, operation, and shut-down procedures. Be sure to emphasize safety procedures.	
Objectives 58-59	Use Technical Information Supplement #4 and Transparency Master #44 to explain the proper use of the bench grinder. Demonstrate the use of the bench grinder before allowing students to use the bench grinder. Emphasize proper safety precautions.	
Objectives 60-61	Discuss Technical Information Supplement #5. Demonstrate correct operating procedures of a band saw. Emphasize proper safety precautions. Use Transparency Master #45.	
Objective 62	Demonstrate proper use and safety practices associated with pneumatic portable power drills. Use Technical Information Supplement #6.	
Objective 63	Have students complete Project Guide #5. This is a long project which will take several days to complete.	

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

TECHNICAL INFORMATION SUPPLEMENT #1--Guidelines for Care and Safe Use of Hand
Tools

- A. Use correct tool for the job
- B. Keep tools sharp
- C. Keep tools clean
- D. Inspect tools frequently to make sure they are in good condition
- E. Repair broken or damaged tools promptly
- F. Dispose of broken or damaged tools that cannot be repaired
- G. Store tools properly when not in use
- H. Stay alert when using tools
- I. Wear eye protection

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

TECHNICAL INFORMATION SUPPLEMENT #2--Using a Rule

- I. Basic units of measurement
 - A. Fractional
 - B. Decimal
 - C. Metric
- II. Procedures for using rules
 - A. Use the proper length and graduation
 - B. Use finest graduation for accuracy
 - C. Use a good quality rule
 - D. Never bend or distort a steel rule
 - E. Use only for intended purpose
 - F. Use 1-inch graduation as reference for accuracy
 - G. Use rule on edge for better reading
 - H. Use rule along axis parallel to plane of measurement
- III. Fractional units found on rules
 - A. Eighths scale ($1/8"$)
 - B. Sixteenths scale ($1/16"$)
 - C. Thirty-seconds scale ($1/32"$)
 - D. Sixty-fourths scale ($1/64"$)
- IV. Reading the rule
 - A. Select scale of the required units
 - B. Total the number of graduations
 - C. Count whole inches (when included)
 - D. Reduce graduations to lowest terms

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

TECHNICAL INFORMATION SUPPLEMENT #3--Drill Press Safety Precautions and Parts

I. Safety precautions

A. Obtain permission from the instructor to operate the machine

B. Wear proper clothing and eye protection

(NOTE: Remove jewelry, do not wear loose clothing, and tie back hair.)

C. Make sure all guards are in place and are operating properly

D. Hold material securely with vise or clamps

E. Be sure key is removed from chuck

F. Select a properly sharpened bit

(NOTE: When drilling metal, use a center punch to mark where hole is to be drilled.)

G. Turn off power if drill is caught in the workpiece

H. Adjust table or depth stop to avoid drilling into table

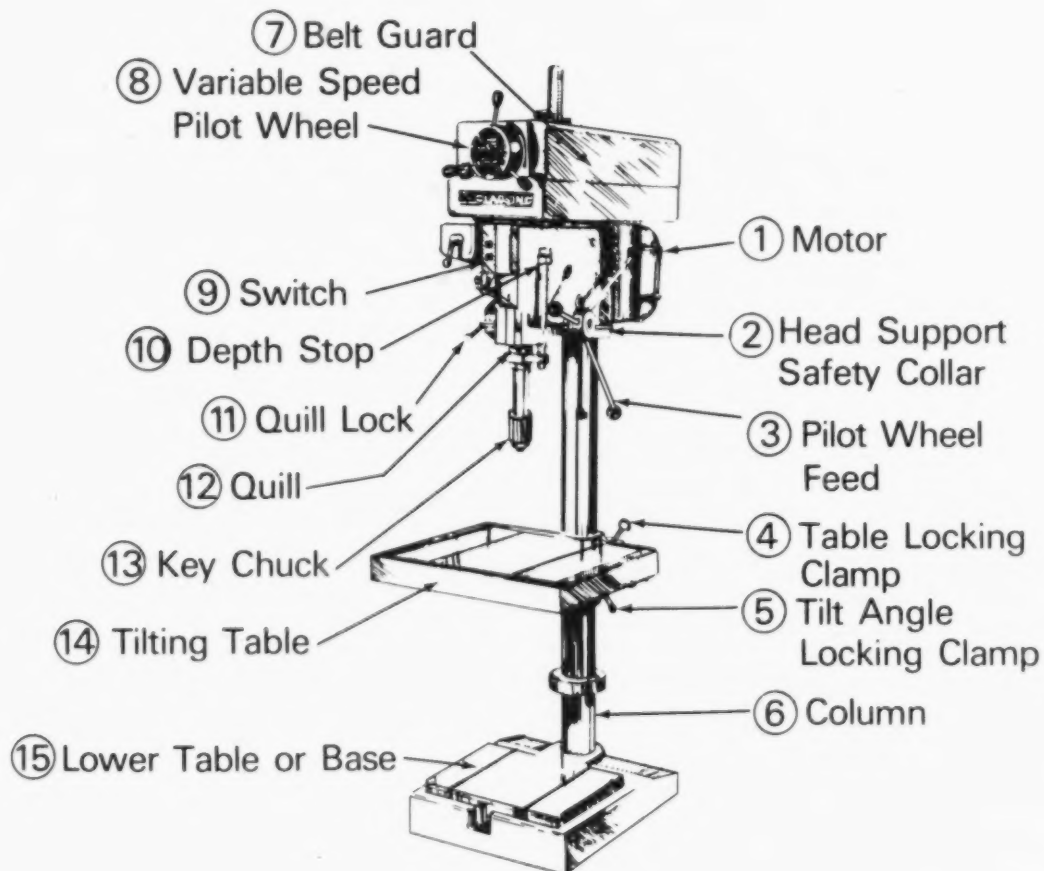
I. Select the correct speed for material being drilled

(NOTE: Use a slower speed for drilling harder metal. The larger the bit, the slower the speed.)

J. Withdraw bit frequently when drilling large or deep holes to prevent damage to bit

K. Use cutting oil when drilling metals to cool drill bit

II. Parts of the drill press



III. Uses of the drill press

- A. Drilling
- B. Countersinking
- C. Reaming
- D. Honing
- E. Counterboring

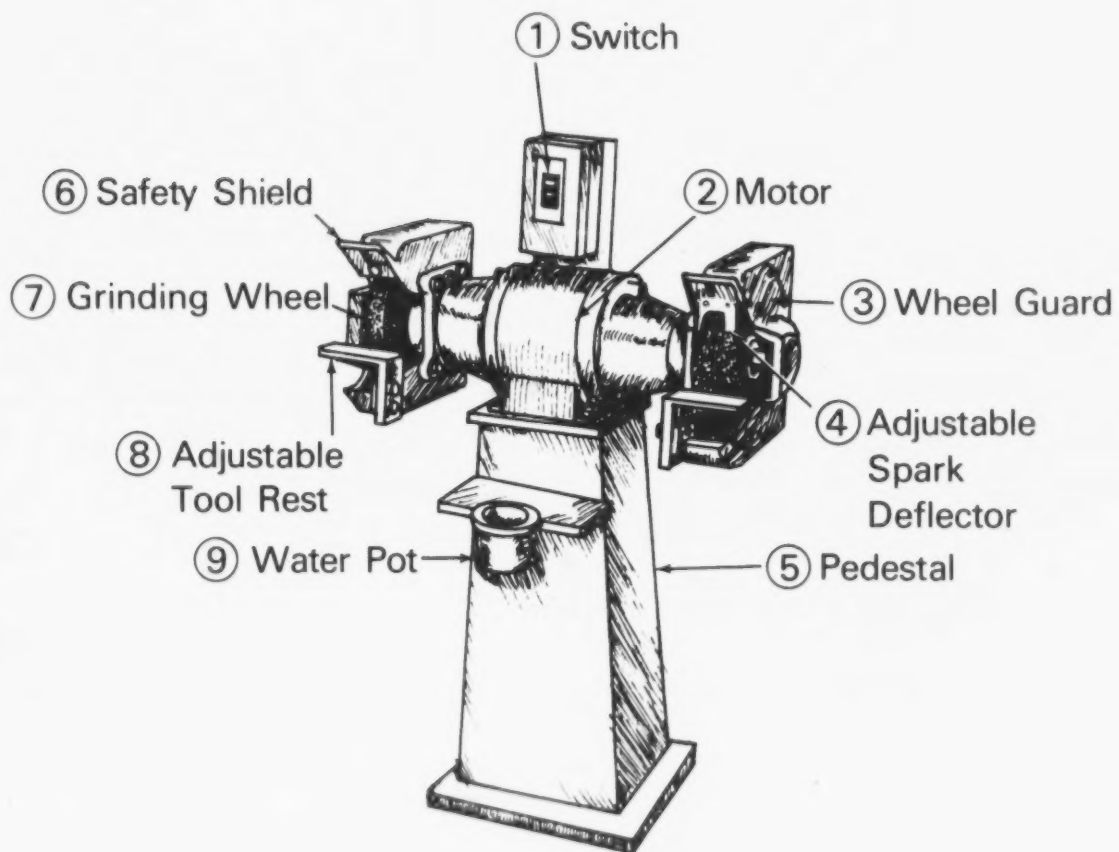
GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

TECHNICAL INFORMATION SUPPLEMENT #4--Bench Grinder Safety Precautions and Parts

I. Safety precautions

- A. Obtain permission from the instructor before operating grinder
- B. Wear proper clothing and face shield, safety glasses, or goggles
- C. Use glass safety guard on grinder
- D. Set tool rest $1/16$ to $1/8$ inch from the wheel
- E. Dress wheel when necessary
- F. Make sure that only the operator is in the operator's zone
- G. Adjust grinder for your job before turning power on
- H. Stand to one side of the wheel when turning power on
- I. Turn power on after receiving instructor's permission
- J. Keep hands away from the wheel while it is in operation
- K. Hold work with your hands; hold small objects with vise grips
- L. Use only the face of the wheel
- M. Use correct amount of pressure to press material against the wheel
- N. Do not grind in areas where flammable materials and liquids are present
- O. Use the proper stone for the metal being ground

II. Parts of the bench grinder



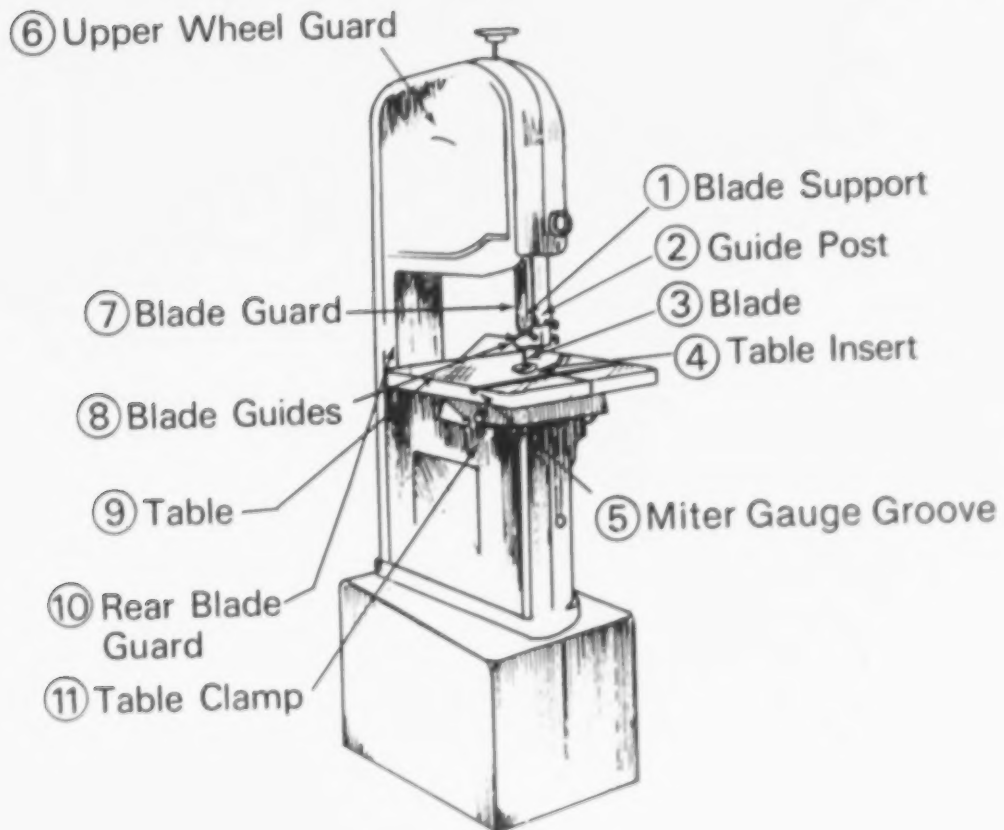
GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

TECHNICAL INFORMATION SUPPLEMENT #5--Band Saw Safety Precautions and Parts

I. Safety precautions

- A. Obtain instructor's permission before operating machine
- B. Wear proper clothing and safety glasses while operating machine
- C. Keep guards in place
- D. Adjust guard to about 1/4 inch above thickness of stock
- E. Adjust upper and lower guides when machine is stopped completely
- F. Stop machine immediately if blades click or become cracked
- G. Allow saw to stop naturally so that blade will not be damaged
- H. Plan cuts carefully
- I. Shut power off before trying to remove stock that may be pinched or bound in machine
- J. Use proper blade width for work being done
- K. Stand on the left side of the machine
- L. Maintain proper blade tension
- M. Keep blade sharp and properly set at all times
- N. Remove scrap material from saw table with a brush
- O. If blade breaks, shut power off and stand clear until the machine completely stops
- P. Always make cuts under power
- Q. Leave machine only after power has been turned off and the blade has stopped moving
- R. Do not feed material too rapidly

II. Parts of the band saw



GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

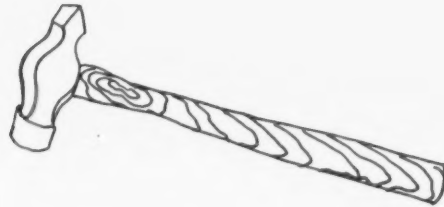
TECHNICAL INFORMATION SUPPLEMENT #6--Pneumatic Portable Power Drill Safety
Precautions

- A. Make sure all air fittings are securely connected to drill
- B. Always use well-sharpened bits
- C. Make sure that the drill is properly oiled and maintained
- D. Always know what is behind the material being drilled
- E. Use only enough pressure to cause one long, spiral chip to form
- F. Avoid wearing loose clothing, and tie back long hair
- G. Do not key chuck while air line is coupled

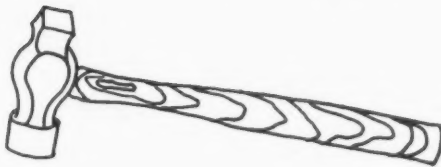
Types of Hammers



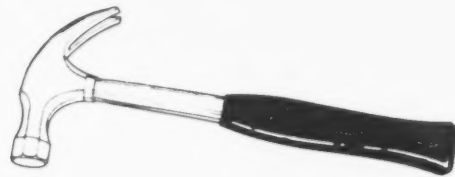
Ball Peen Hammer



Cross Peen Hammer



Straight Peen Hammer



Claw Hammer



Sledgehammer

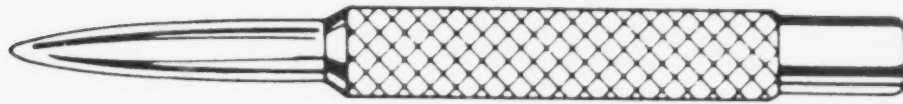


Body Hammer

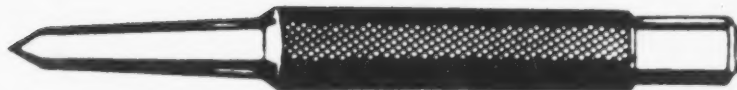


Mallet
(Plastic with Replaceable Tip)

Types of Punches



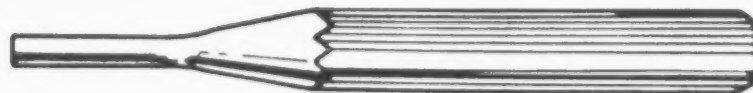
Prick Punch



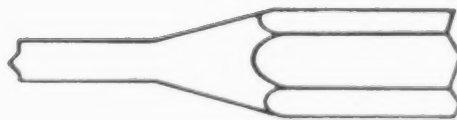
Center Punch



Starting Punch or
Drift Punch



Pin Punch



Transfer Punch

Types of Pliers

Holding Pliers



Slip-Joint Pliers



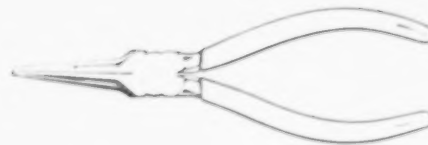
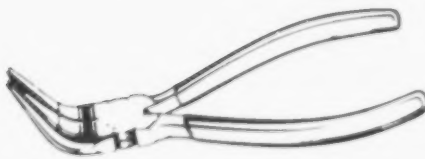
Inter-Locking-Joint Pliers



Vise-Grip Pliers



Duckbill Pliers



Needle-Nose Pliers

Cutting Pliers

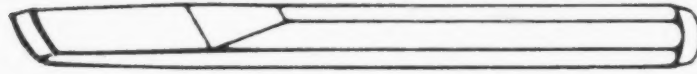


Diagonal Cutters



Safety Wire
Cutters/Twisters

Types of Chisels Used by the Aviation Technician



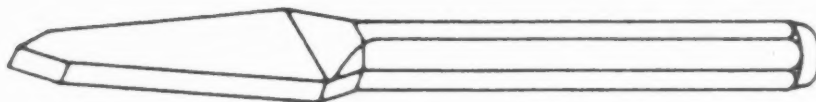
Flat or Cold Chisel



Diamond-Point Chisel



Single-Bevel Cape Chisel



Double-Bevel Cape Chisel

Types of Files



Mill File



Hand File



Half-Round File



Three-Square/
Triangular File



Knife File



Round File



Wood Rasp

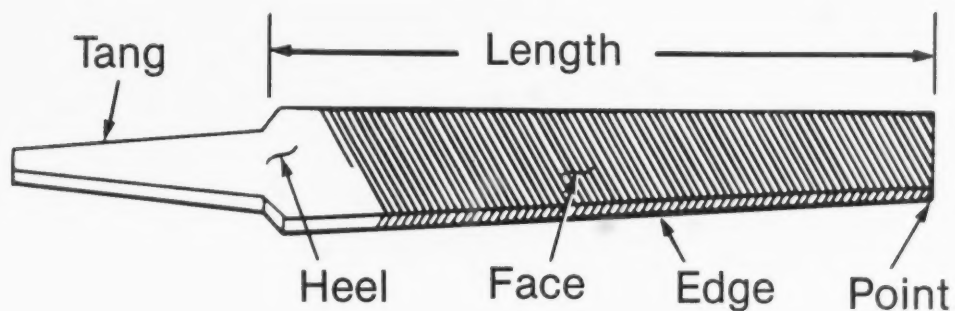


Vixen File



File Handle

Parts of a File; Cuts and File Card



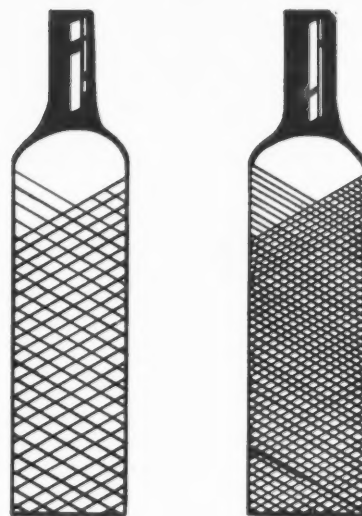
Single Cut



Coarse

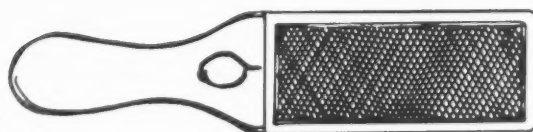
Smooth

Double Cut



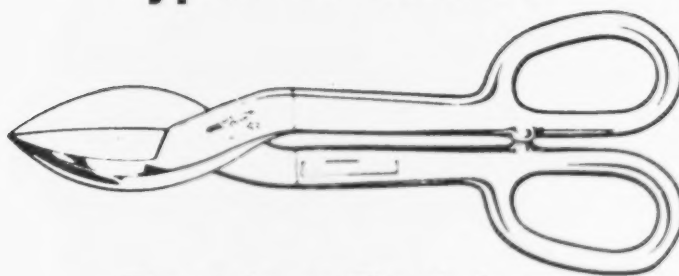
Coarse

Smooth

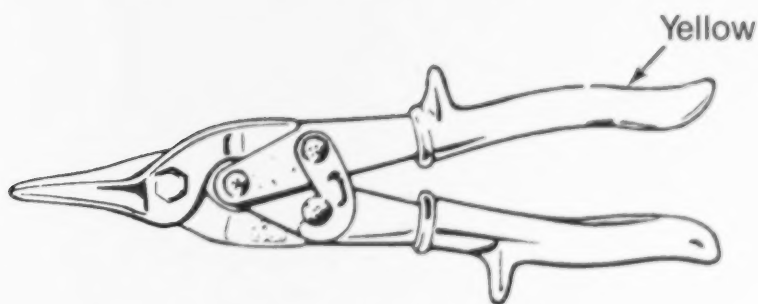


File Card

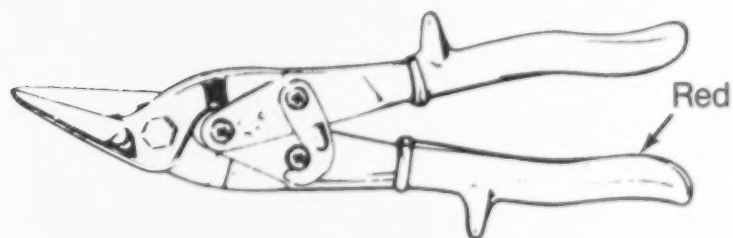
Types of Shears



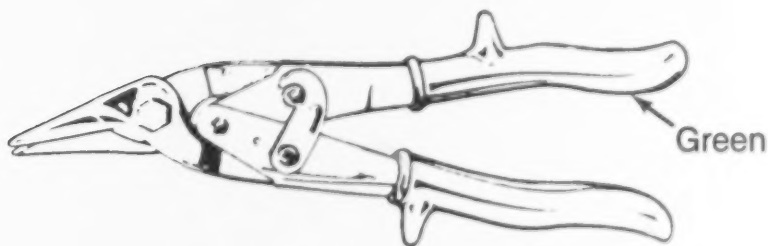
Tinner's or Tin Snips



Straight-Cut Aviation Snips

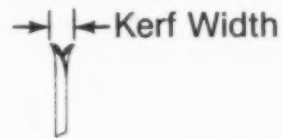


Left-Cut Aviation Snips



Right-Cut Aviation Snips

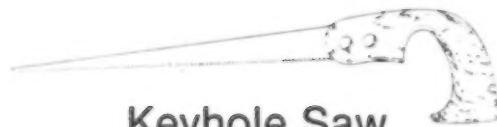
Types of Hand Saws



Cross-Cut Saw



Rip Saw



Keyhole Saw



Backsaw



Hacksaw

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TM #8

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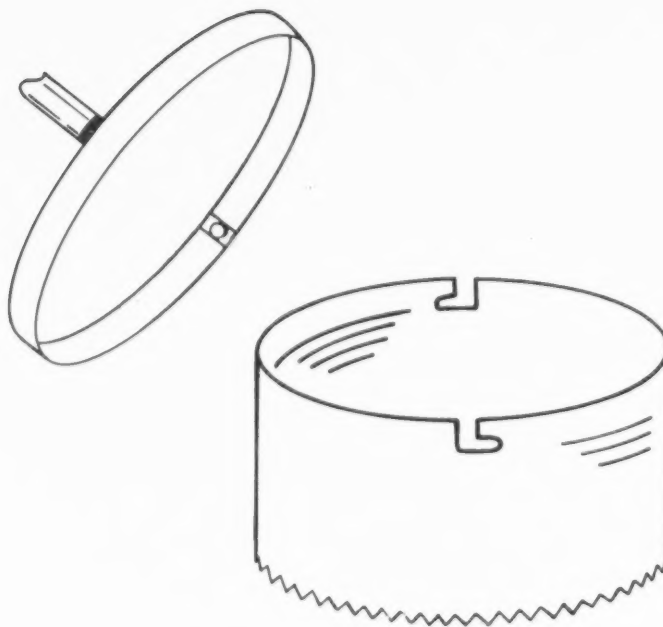
Types of Wood-Boring Bits



Wood Auger Bit

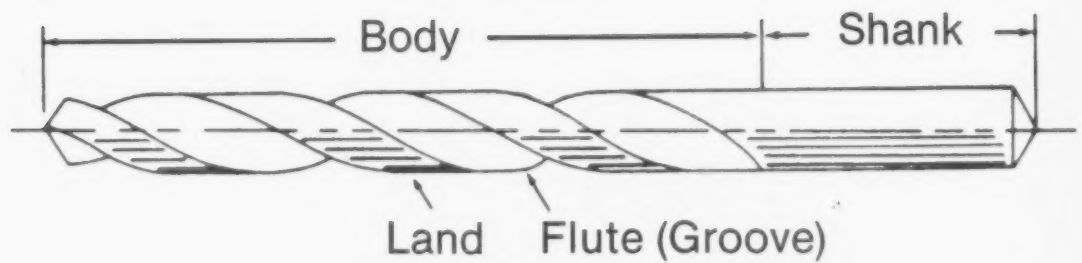


Flat Wood-Boring Bit

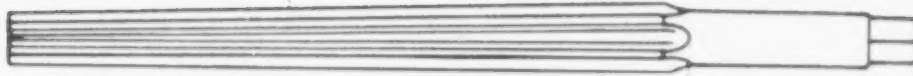


Drum Hole Saw and Holding Fixture

Parts of a Twist Drill



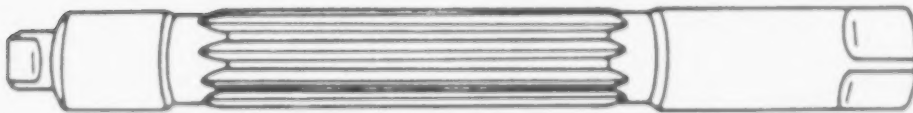
Types of Reamers



Tapered Reamer with Straight Flutes



Tapered Reamer with Spiral Flutes



Expansion Reamer with Straight Flutes



Bottoming Reamer with Straight Flutes

Types of Hand Taps



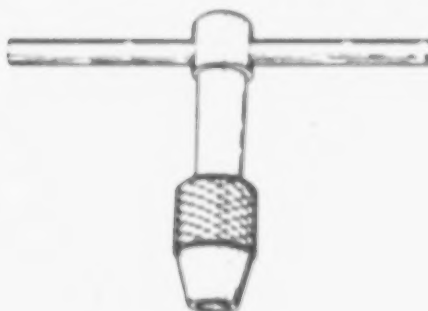
Taper Tap



Plug Tap



Bottoming Tap

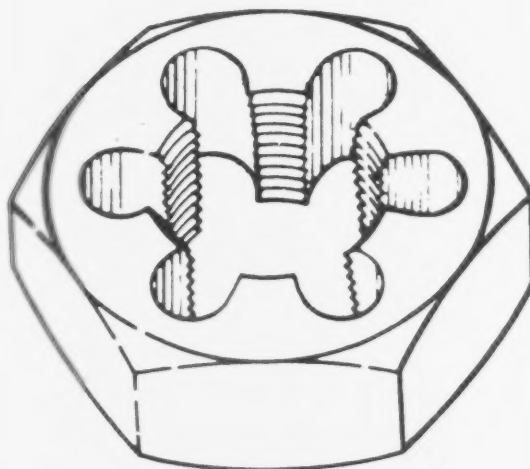


T-Handle for Taps

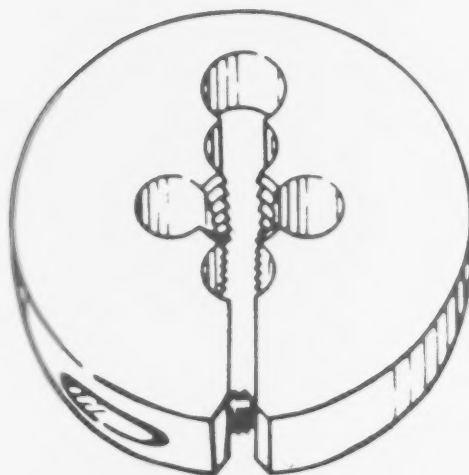


Solid Handle for Taps

Types of Dies Most Often Used by the Aviation Maintenance Technician



Thread-Chasing or Restoring Die



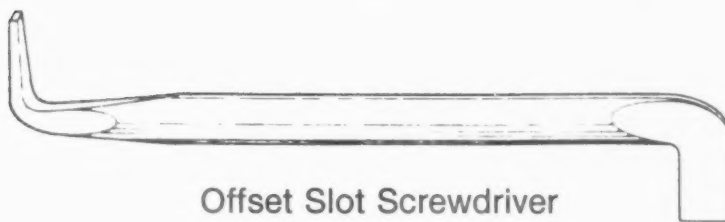
Round Split Die

Types of Screwdrivers

(Turning Tools)



Slotted Screwdriver



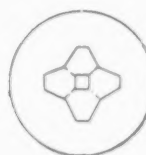
Offset Slot Screwdriver



Yankee Spiral-Type Screwdriver



Reed and Prince Screwdriver



Phillips Screwdriver

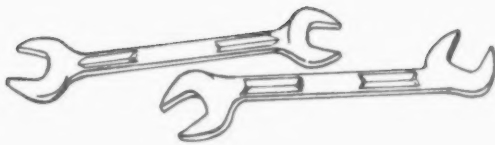


Phillips Posidriv Screwdriver



Phillips Tri-Wing Screwdriver

Types of Wrenches



Open-End Wrench



Box-End Wrench



Combination Wrench



Flare-Nut Wrench



Ratcheting Open-End Wrench

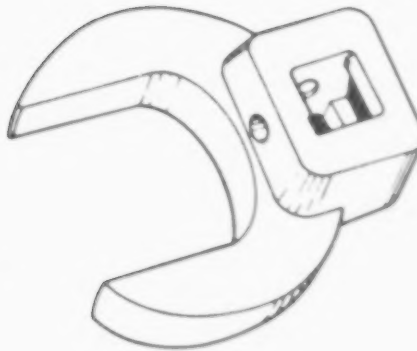


Ratcheting Box-End Wrench

Types of Sockets



Deep Socket



Crowfoot Wrench Socket



Flex Socket

Types of Drivers

Socket



Break-Over Handle



Universal Joint



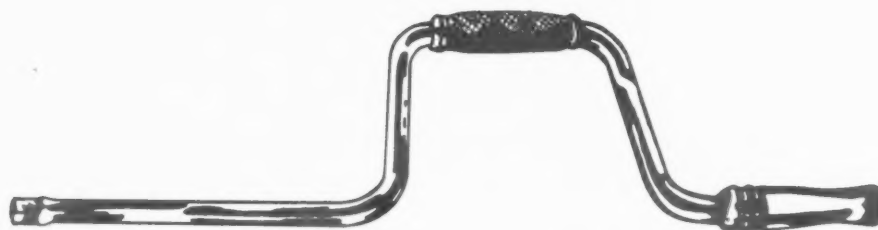
Ratchet Handle



Sliding T-Handle



Speed Handle



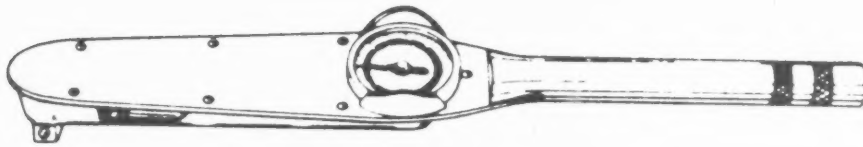
Extension



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TM #17

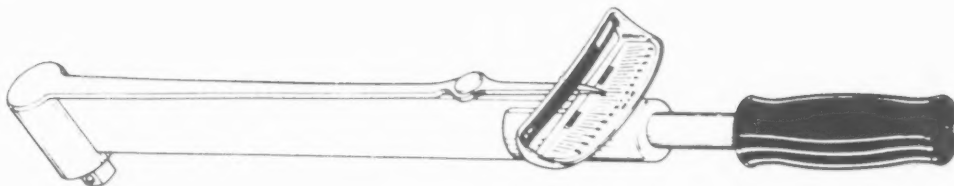
Three Basic Types of Torque Wrenches



Torsion-Bar-Type Torque Wrench
(Dial Indicator)

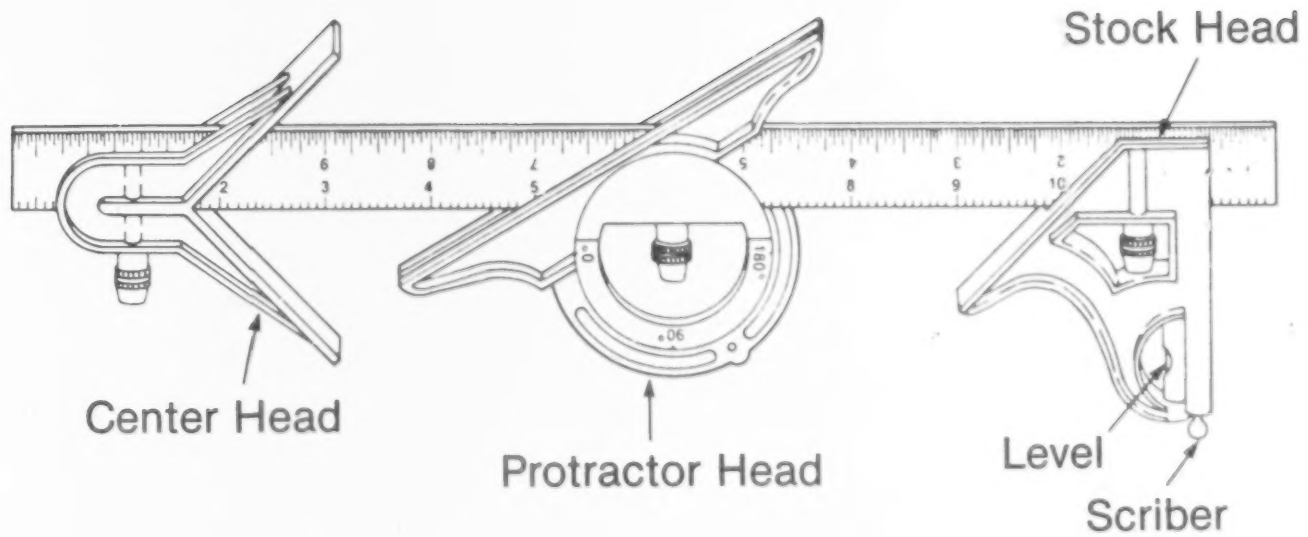


Toggle-Type Torque Wrench
(Breakover)



Deflecting-Beam Torque Wrench

Parts of a Combination Set



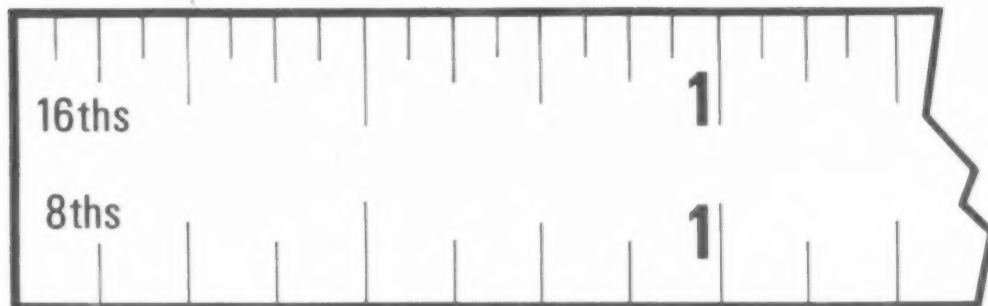
G104B-65

TM #19

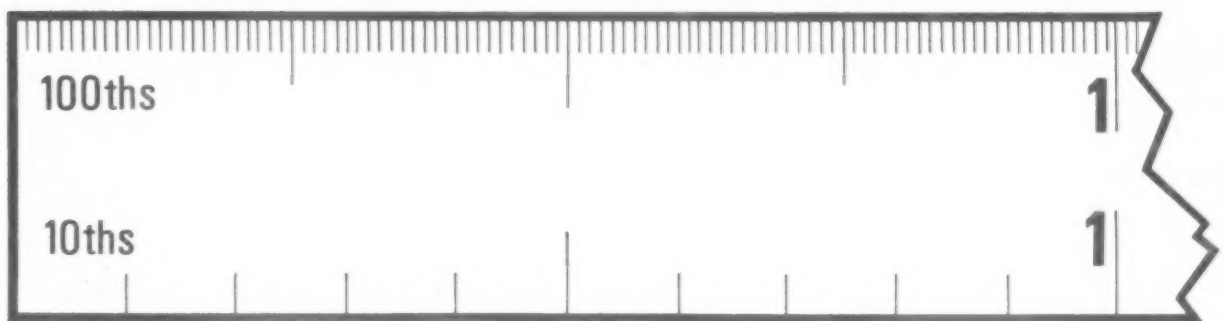
189

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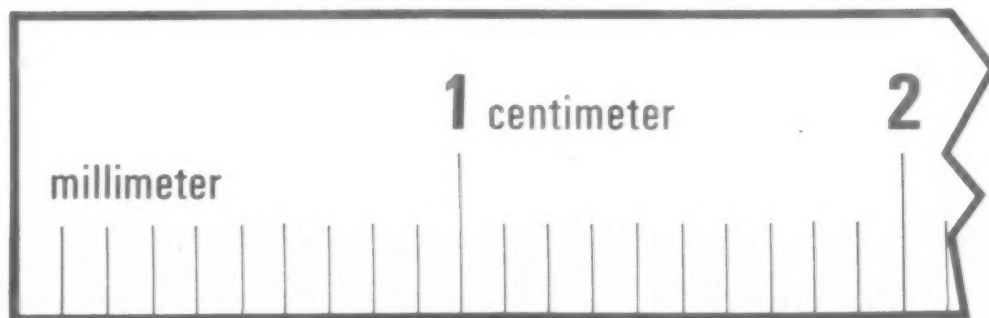
Units of Measurement



Fractional Rule

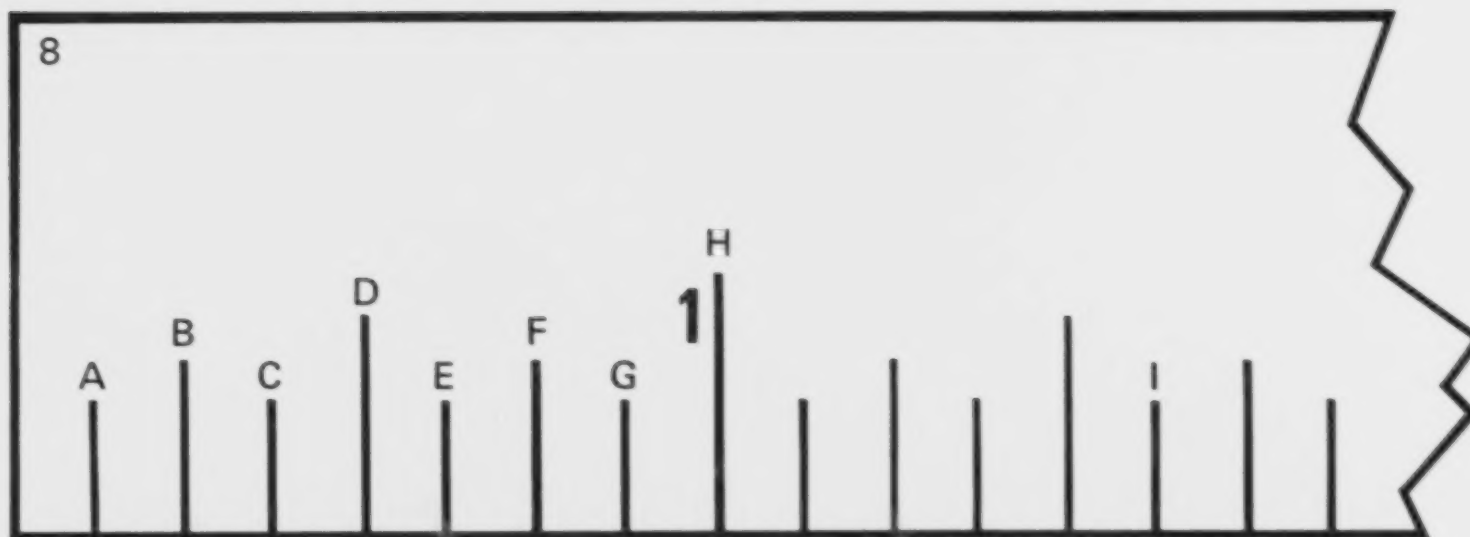


Decimal Rule



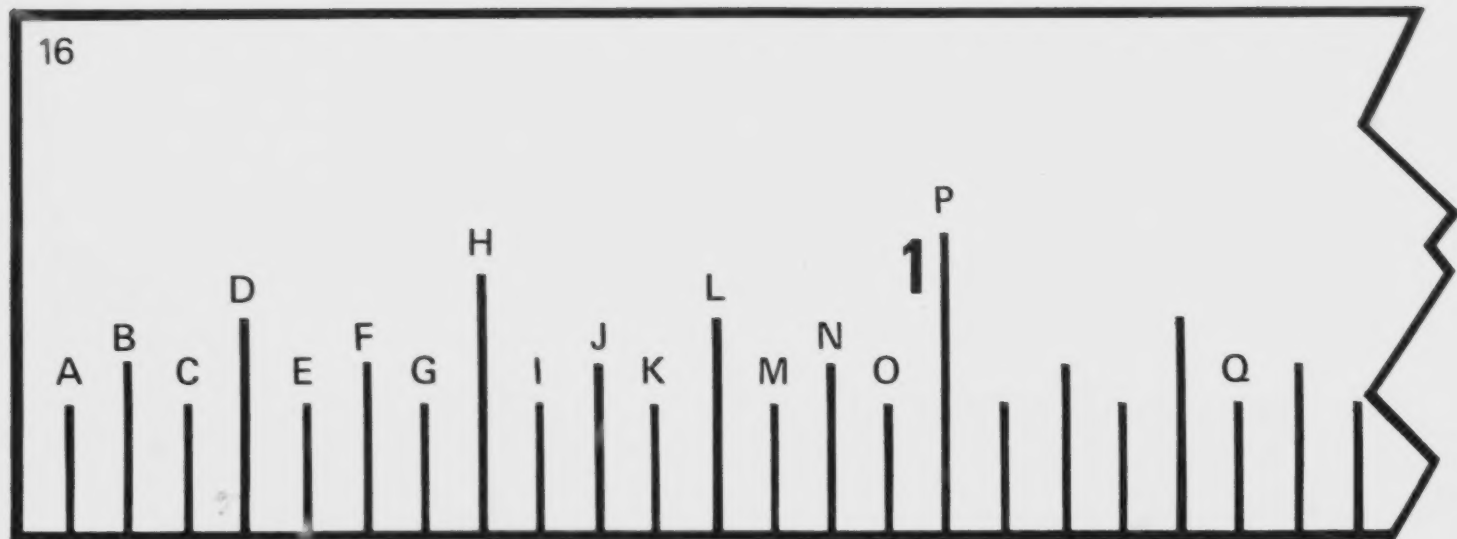
Metric Rule

Eighths Graduations



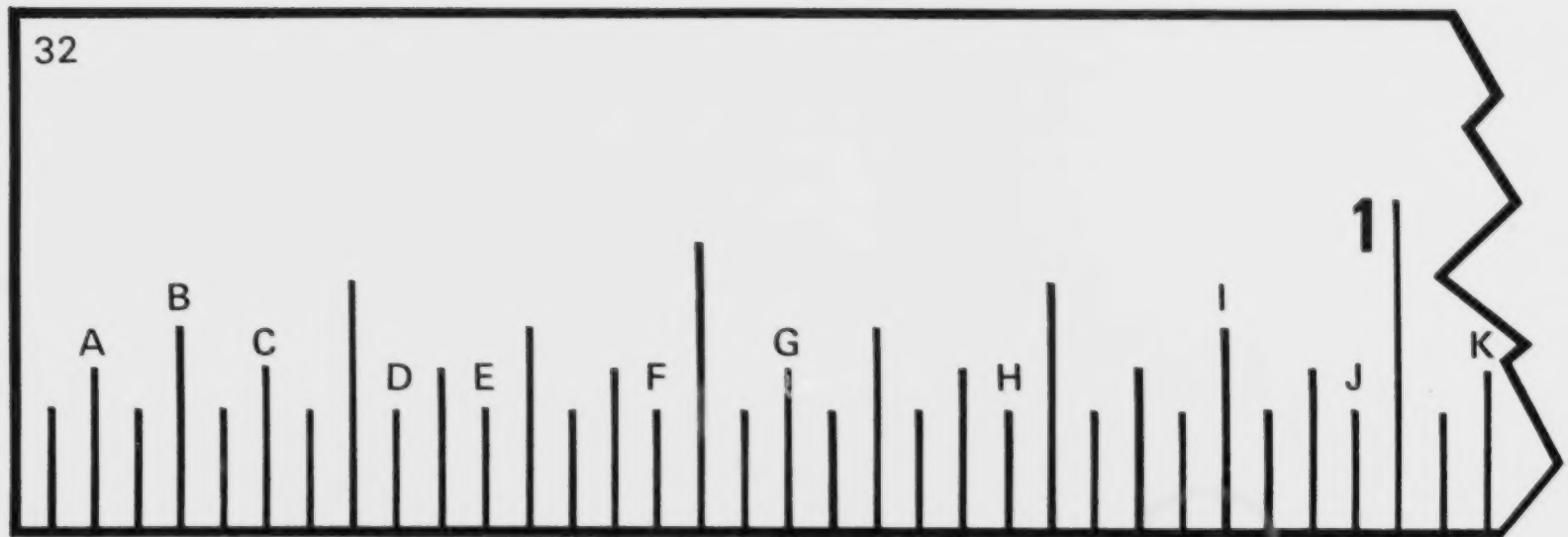
$$\begin{aligned}
 A &= 1/8, B = 2/8 = 1/4, C = 3/8, D = 4/8 = 1/2, \\
 E &= 5/8, F = 6/8 = 3/4, G = 7/8, H = 8/8 = 1, \\
 I &= 13/8 = 1 \frac{5}{8}
 \end{aligned}$$

Sixteenths Graduations



$A = 1/16$, $B = 2/16 = 1/8$, $C = 3/16$, $D = 4/16 = 1/4$,
 $E = 5/16$, $F = 6/16 = 3/8$, $G = 7/16$, $H = 8/16 = 1/2$,
 $I = 9/16$, $J = 10/16 = 5/8$, $K = 11/16$, $L = 12/16 = 3/4$,
 $M = 13/16$, $N = 14/16 = 7/8$, $O = 15/16$, $P = 16/16 = 1$,
 $Q = 22/16 = 1 \frac{6}{16} = 1 \frac{3}{8}$

Thirty-Seconds Graduations

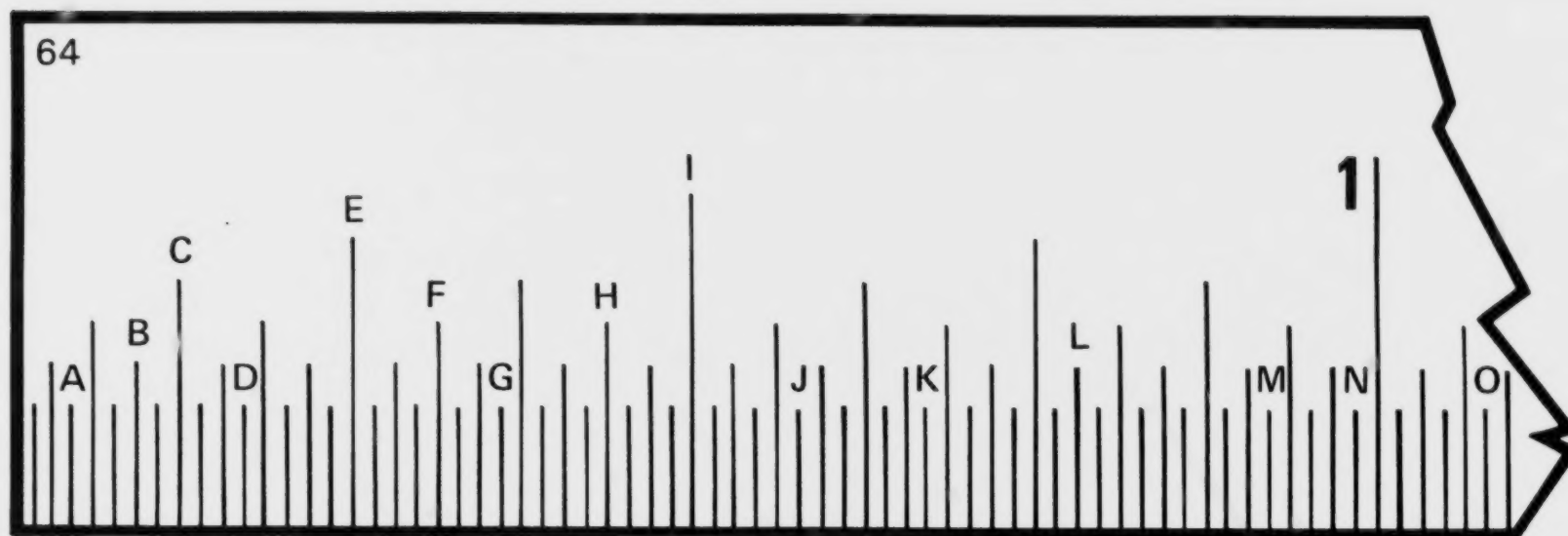


$$\begin{aligned}
 A &= 2/32 = 1/16, & B &= 4/32 = 1/8, & C &= 5/32, & D &= 9/32, \\
 E &= 11/32, & F &= 15/32, & G &= 18/32 = 9/16, & H &= 23/32, \\
 I &= 28/32 = 14/16 = 7/8, & J &= 31/32, \\
 K &= 34/32 = 1 \ 2/32 = 1 \ 1/16
 \end{aligned}$$

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TM #23

Sixty-Fourths Graduations

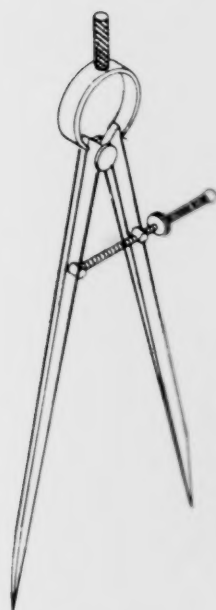


$A = 3/64$, $B = 6/64 = 3/32$, $C = 8/64 = 1/8$, $D = 11/64$,
 $E = 16/64 = 8/32 = 1/4$, $F = 20/64 = 10/32 = 5/16$,
 $G = 23/64$, $H = 28/64 = 14/32 = 7/16$, $I = 32/64 = 1/2$,
 $J = 37/64$, $K = 43/64$, $L = 50/64 = 25/32$, $M = 59/64$,
 $N = 63/64$, $O = 69/64 = 1 \frac{5}{64}$

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TM #24

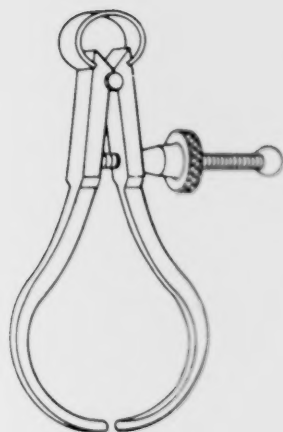
Dividers and Calipers



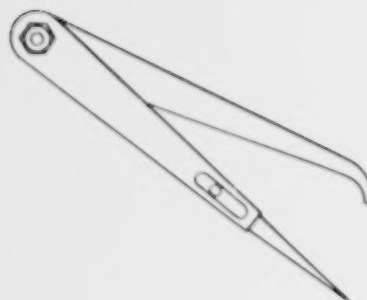
Dividers



Inside Calipers

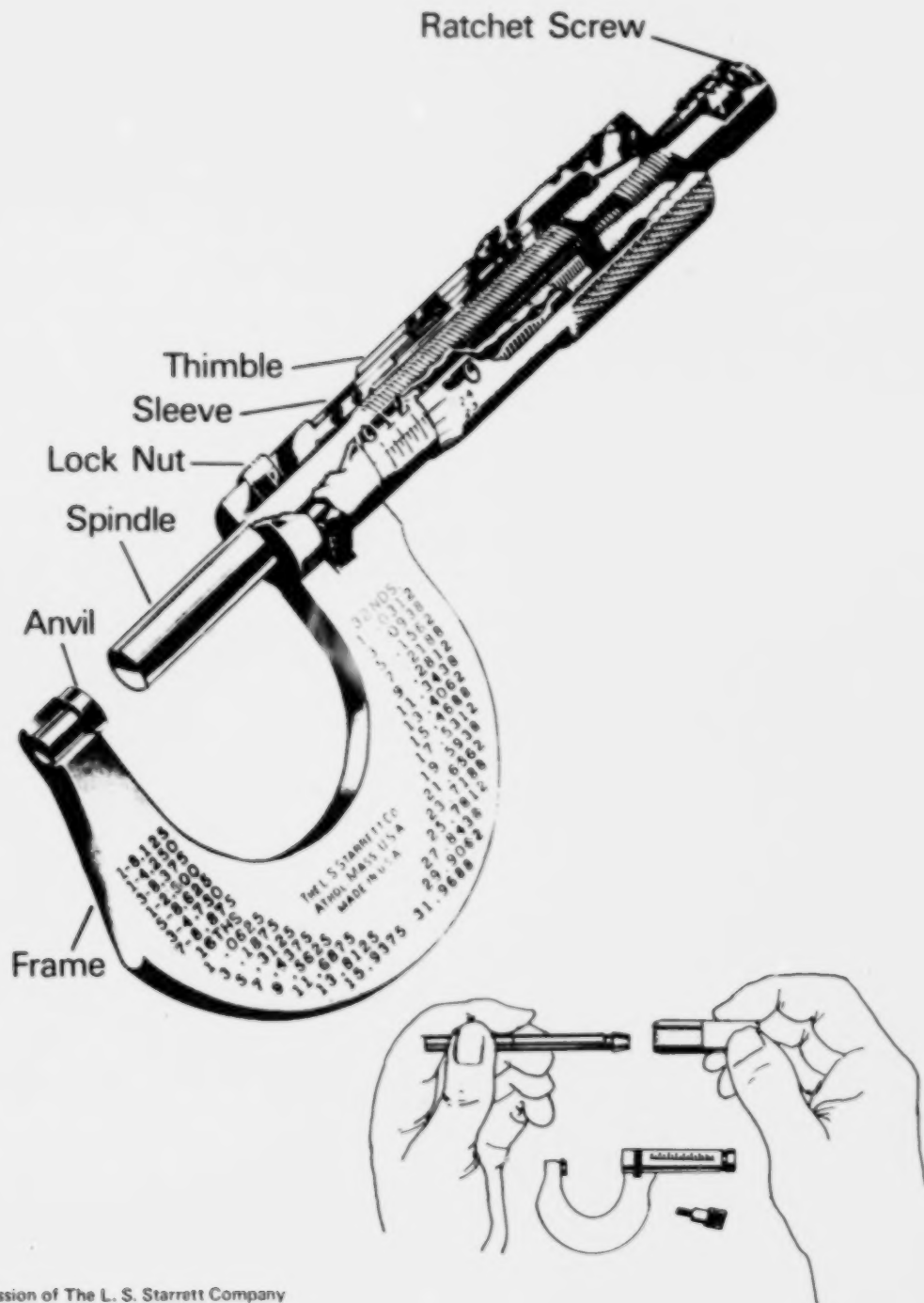


Outside Calipers



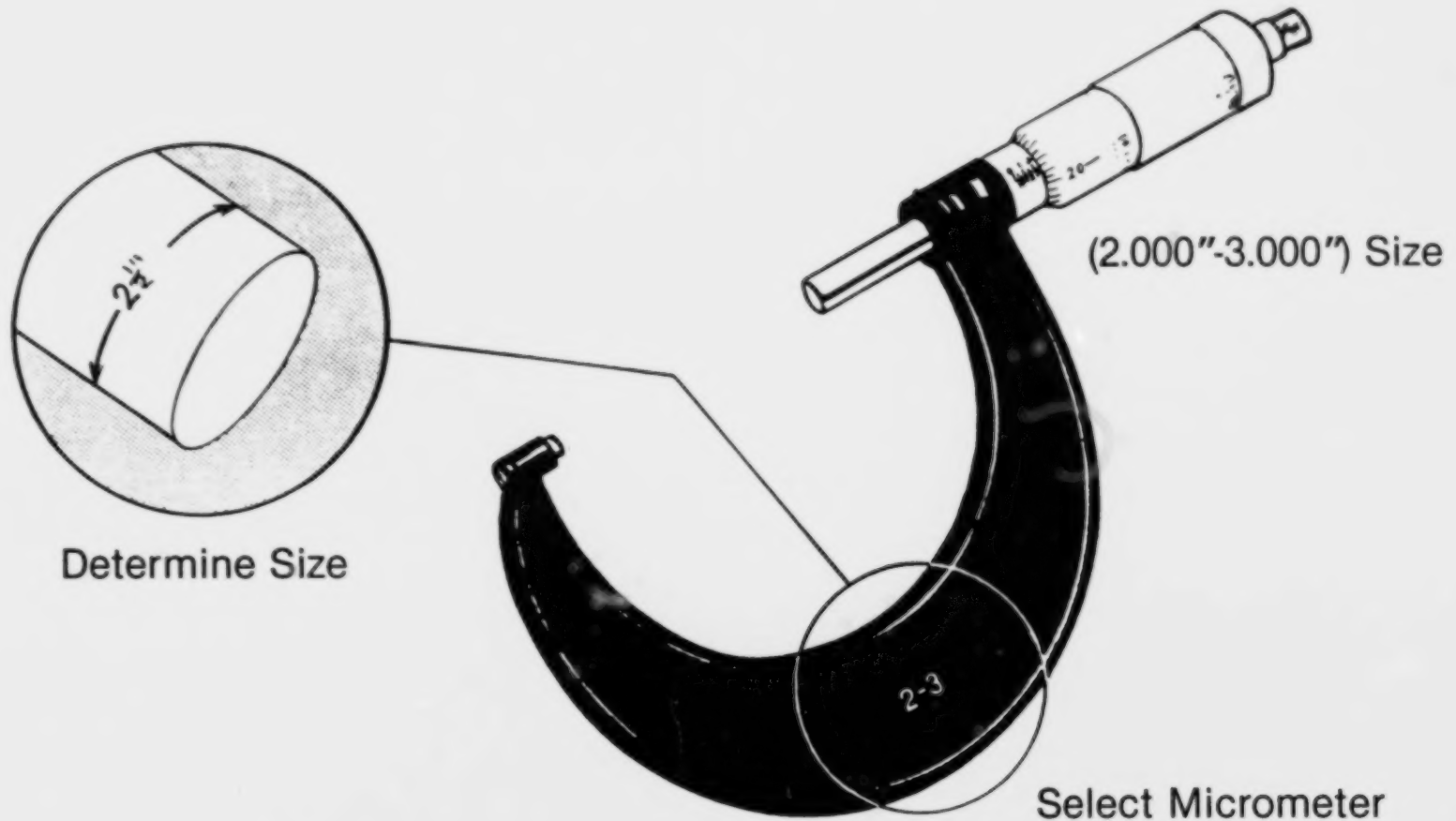
Hermaphrodite Calipers

Parts of a Micrometer



Used with permission of The L. S. Starrett Company

Selecting the Proper Size Micrometer



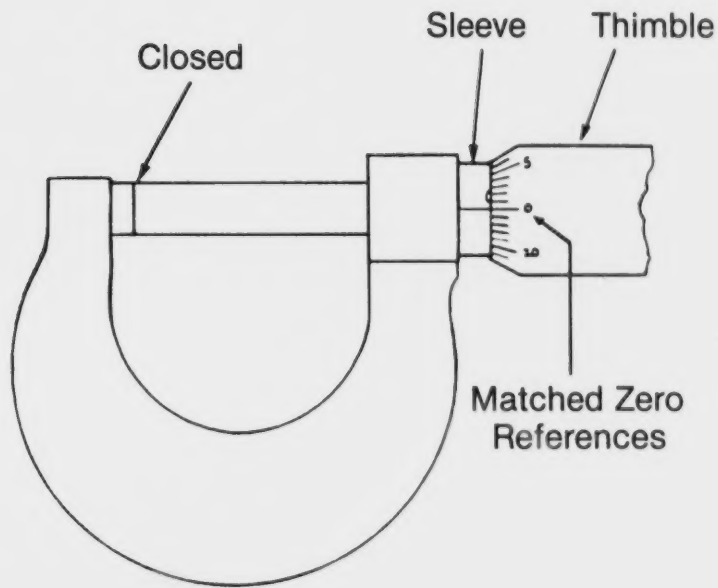
G104B-81

202

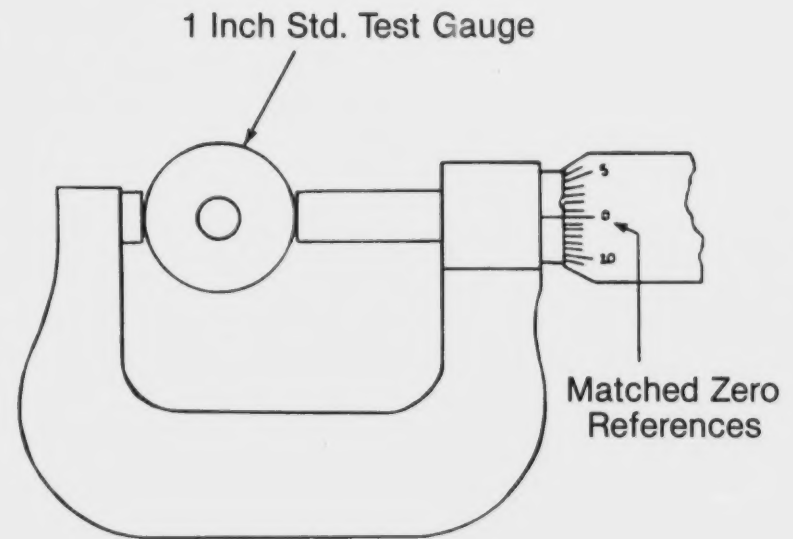
TM #27

203

Checking the Micrometer for Accuracy



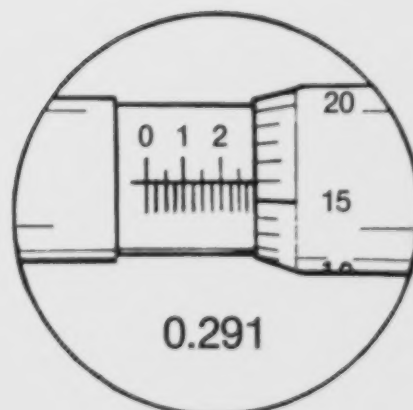
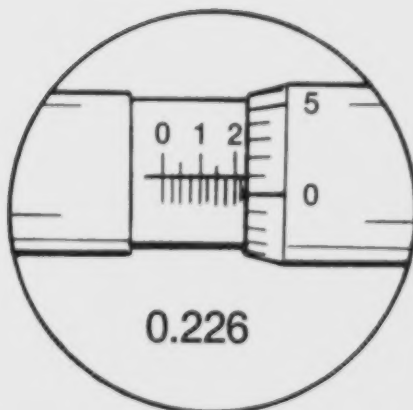
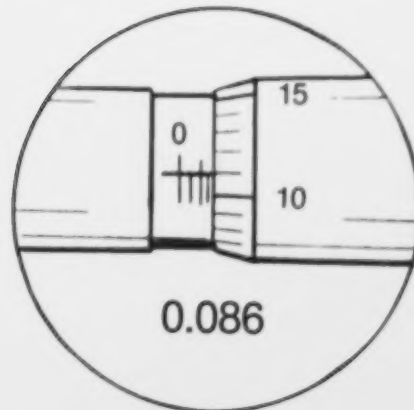
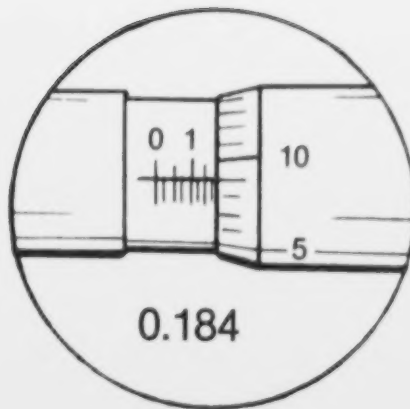
1 Inch Micrometer



2 Inch Micrometer

G104B-83

Reading a Micrometer



Micrometer Sleeve Readings



G104B-87

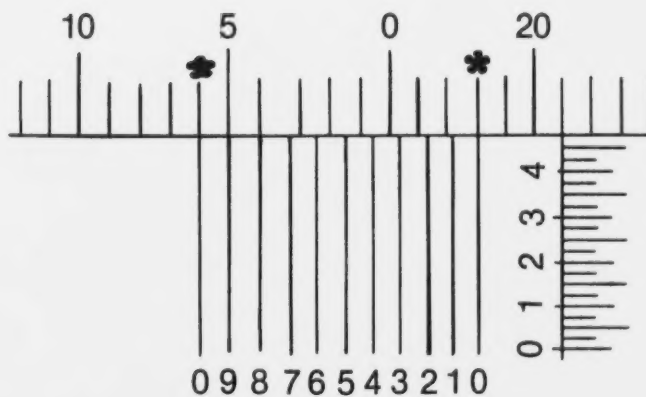
238

237

TM #30

Vernier Micrometer Readings

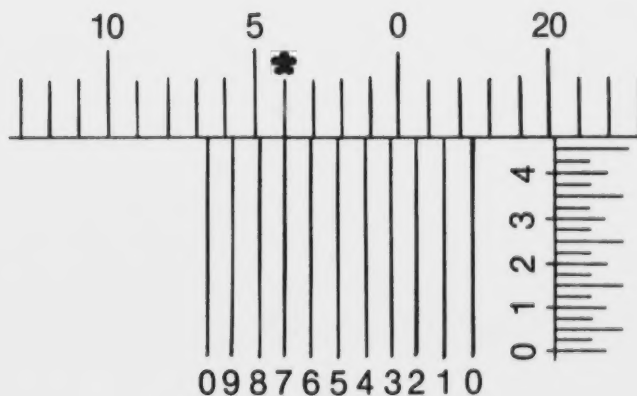
Thimble



Sleeve

0.4690

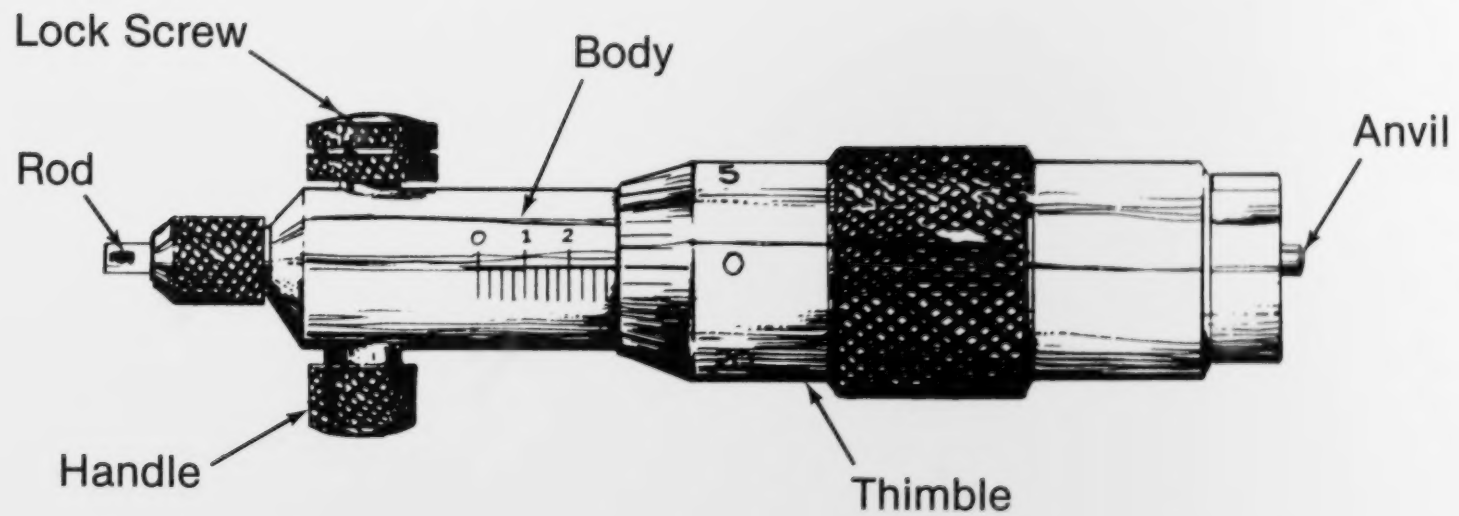
Thimble



Sleeve

0.4697

Parts of the Inside Micrometer



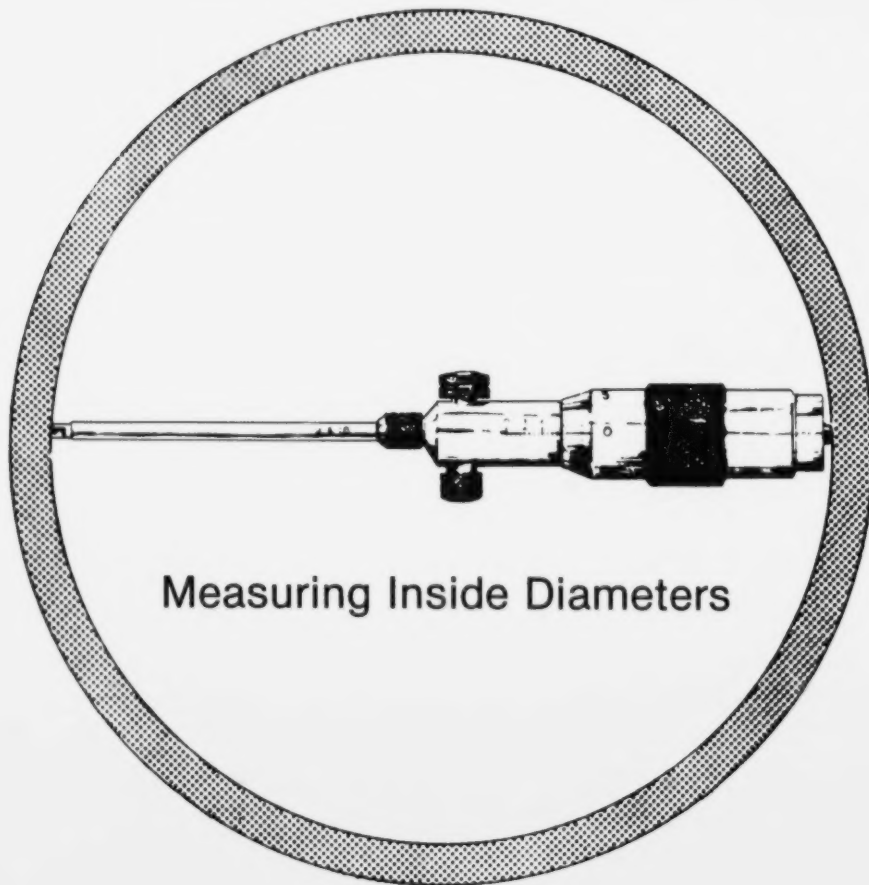
G104B-91

211

TM #32

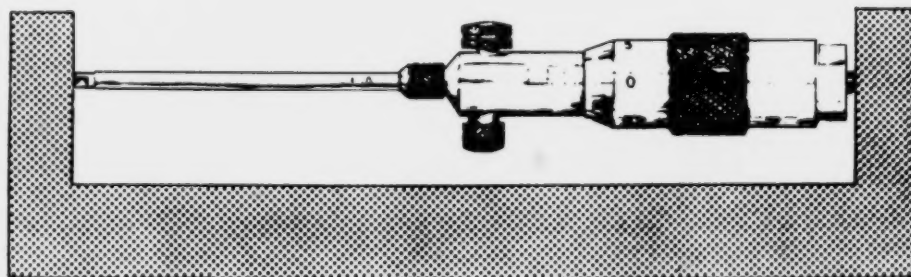
210

Uses of the Inside Micrometer

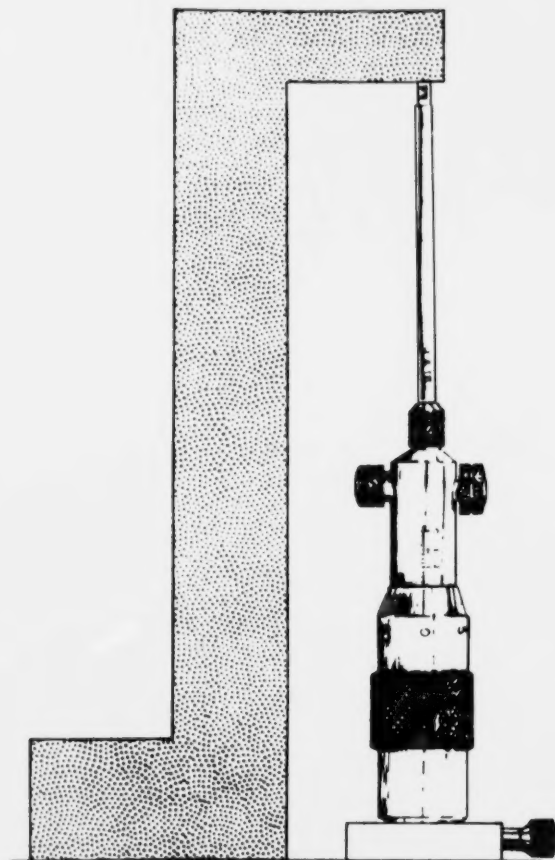


Measuring Inside Diameters

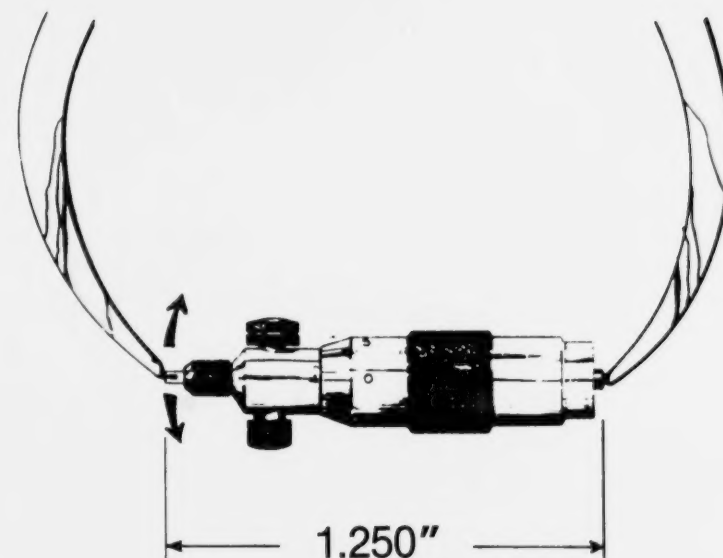
Measuring Widths



Uses of the Inside Micrometer (Continued)



Height Gage



Measurement Transfer

G104B-95

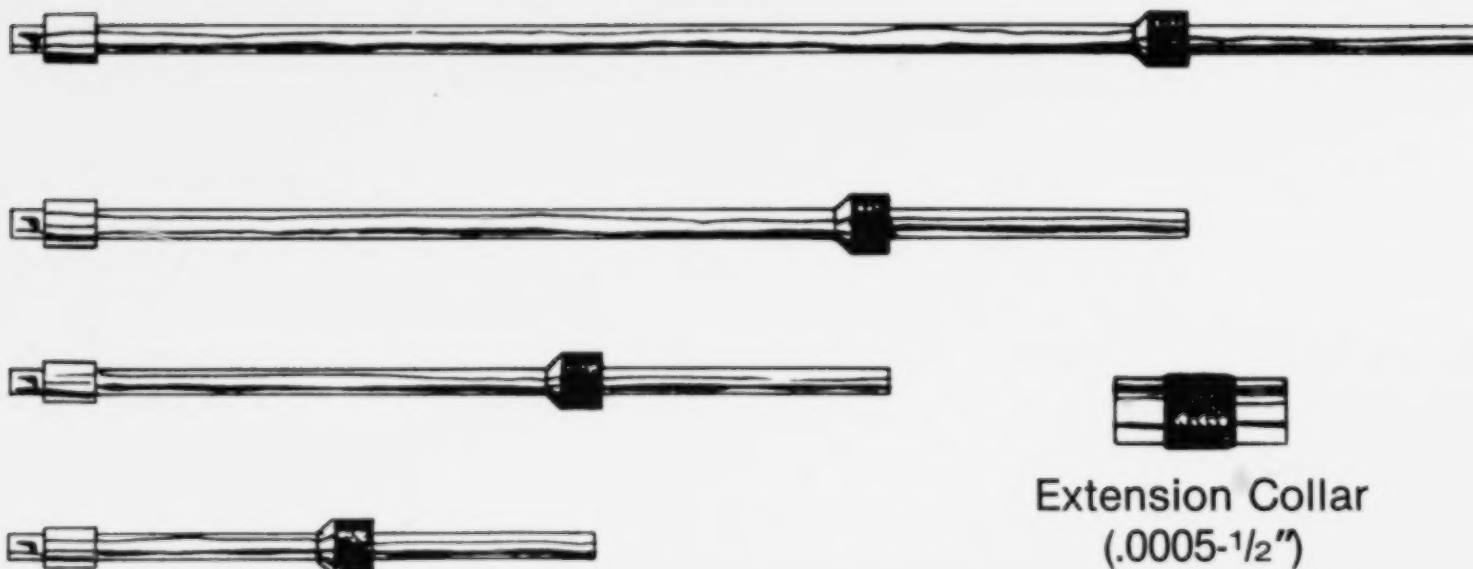
TM #34

213

214

Inside Micrometer Set

Extension Rods



Extension Collar
(.0005-1/2")

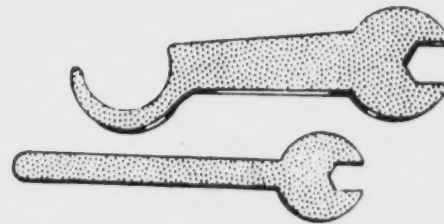
G104B-97

TM #35

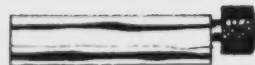
215

216

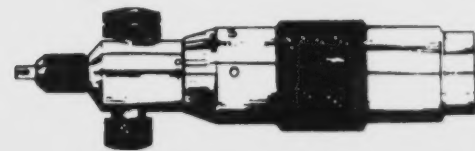
Inside Micrometer Set (Continued)



Wrenches



Height Gage Base



Base Unit

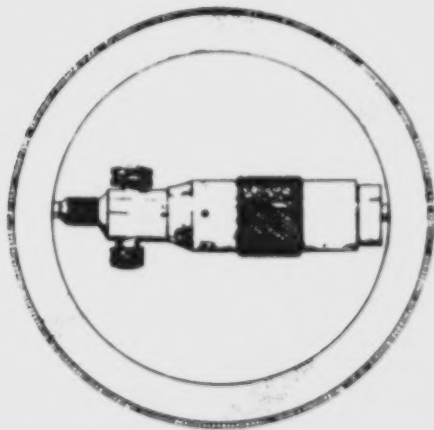


Extension Handle

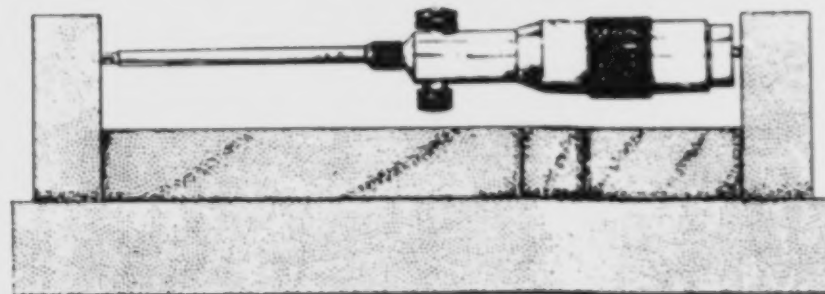
G104B-99

TM #36

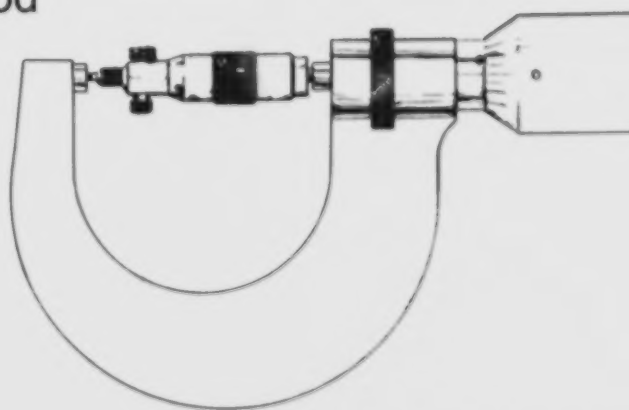
Methods of Checking Inside Micrometers for Accuracy



Ring Gage Method

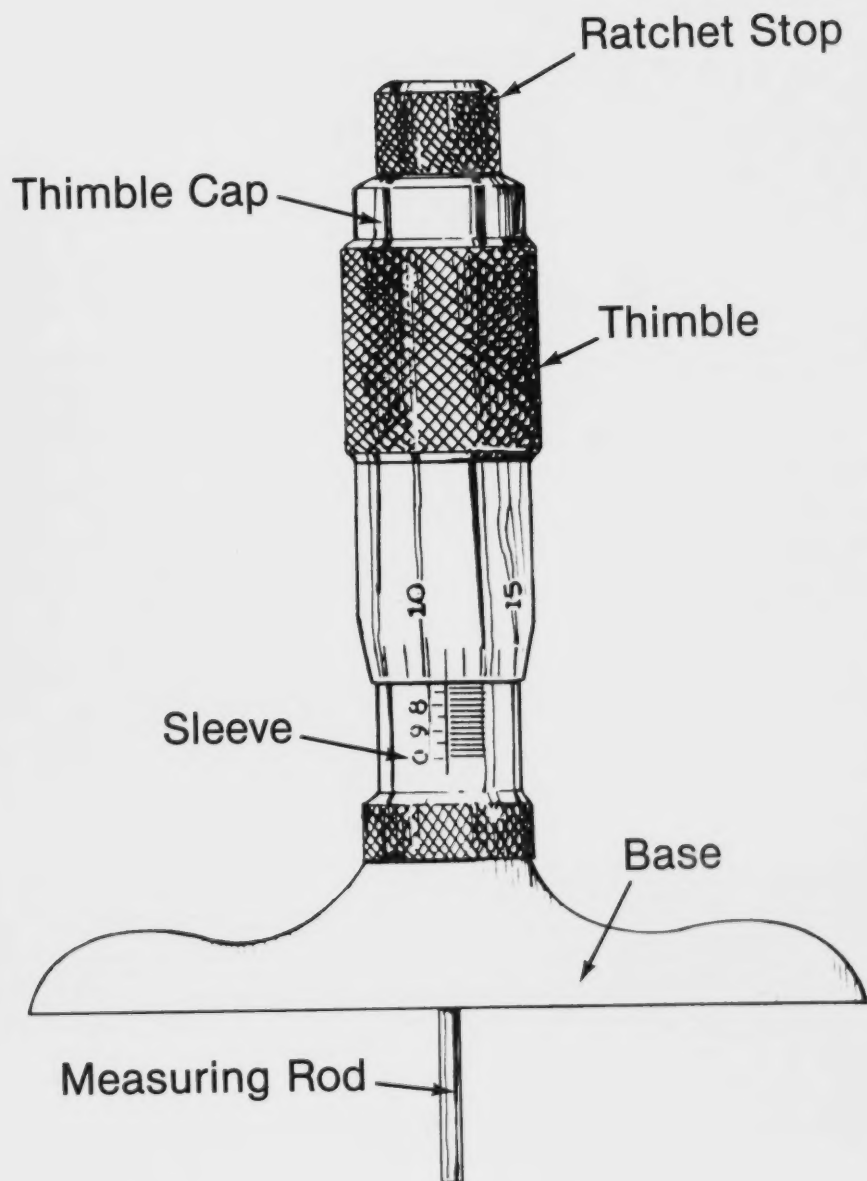


Gage and Block Method

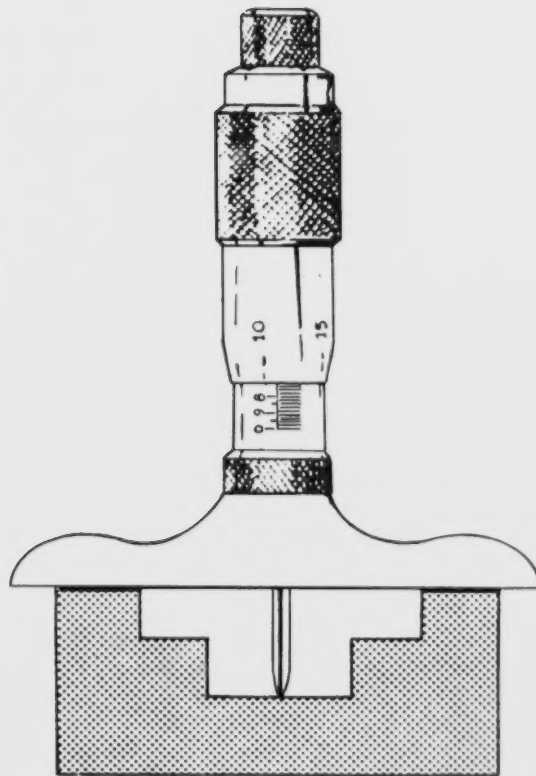


Outside Micrometer Method

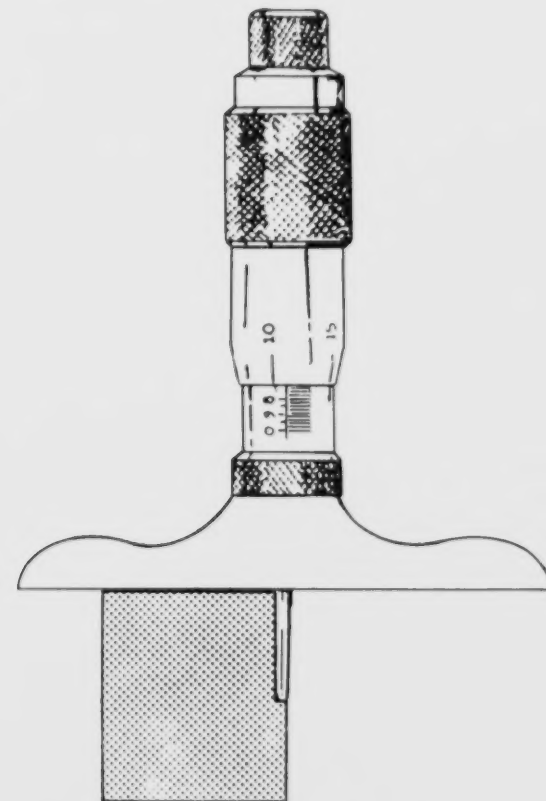
Parts of a Depth Micrometer



Uses of the Depth Micrometer

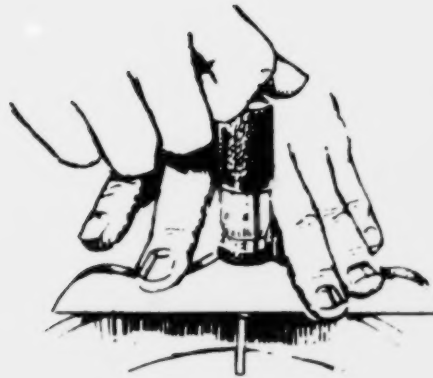


Measuring Depth of Milled Slot

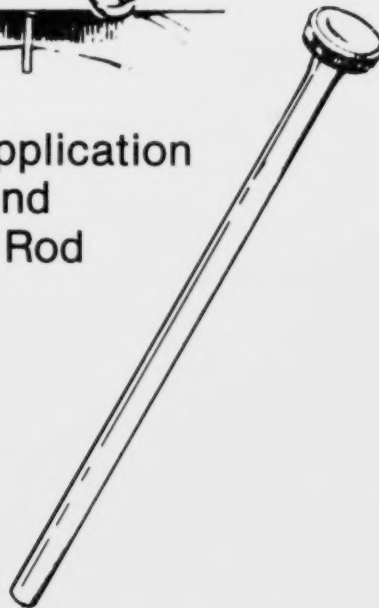


Measuring Shallow Recess

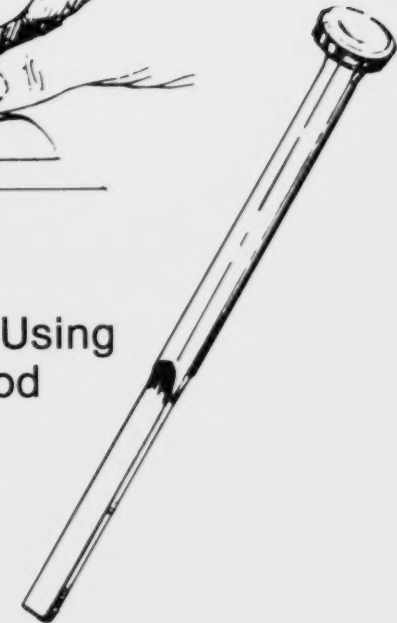
Types of Extension Rods



General Application
Using Round
Extension Rod



Slot Measurement Using
Blade Extension Rod



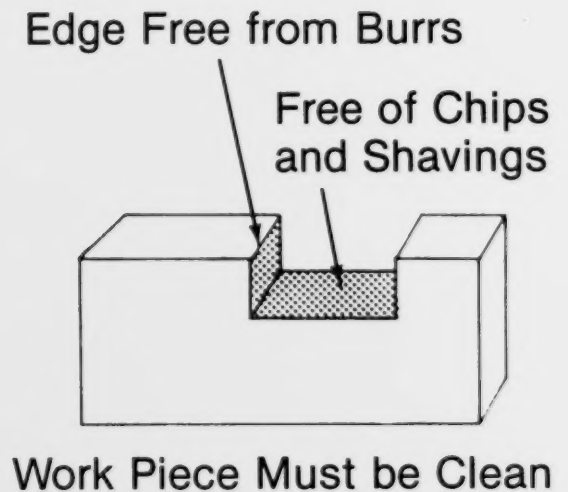
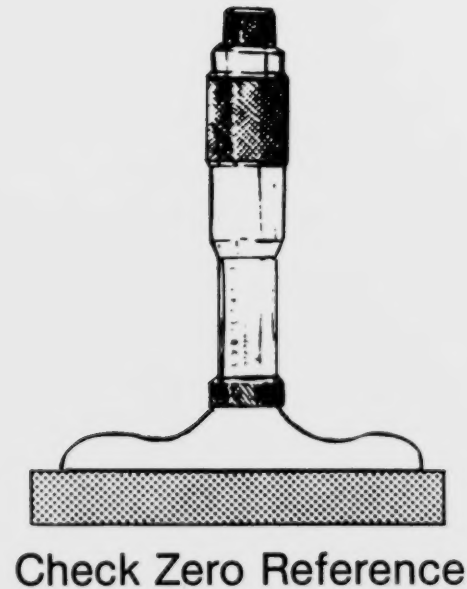
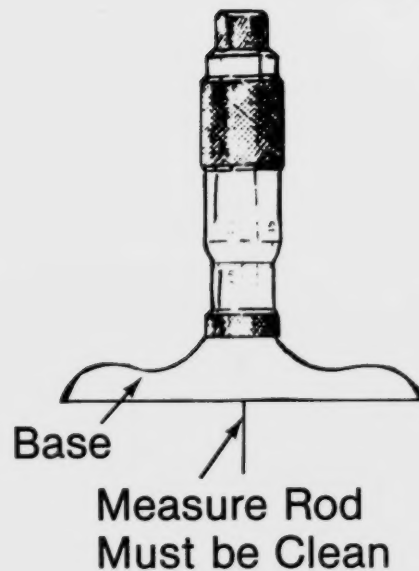
G104B-107

TM #40

224

225

Preparing the Depth Micrometer and Workpiece for Measurement



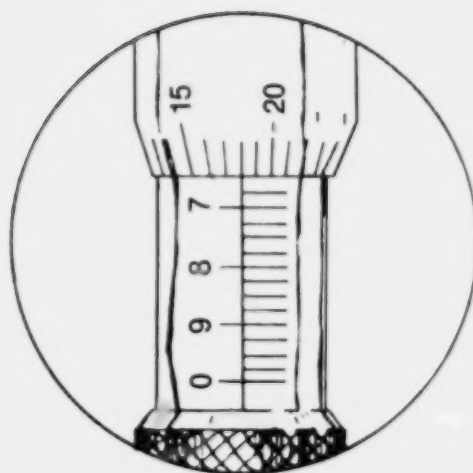
G104B-109

TM #41

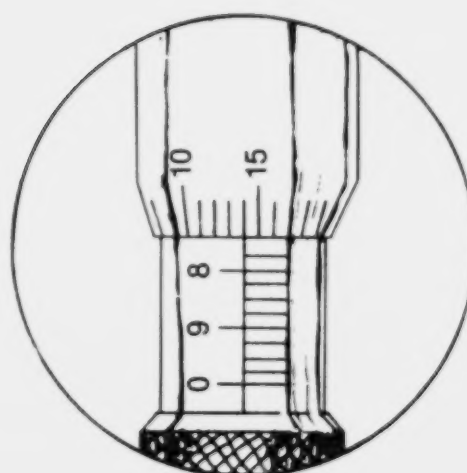
226

227

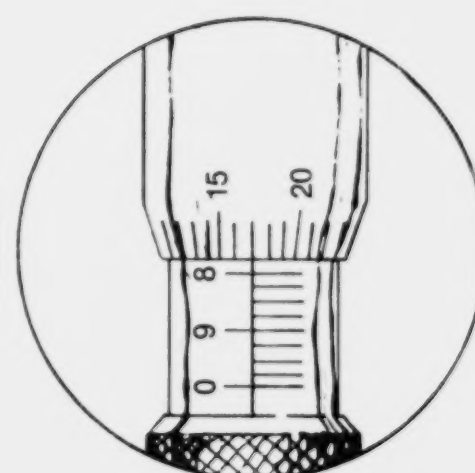
Reading the Depth Micrometer



$$.650 + .018 = .668$$



$$.750 + .014 = .764$$



$$.775 + .017 = .792$$

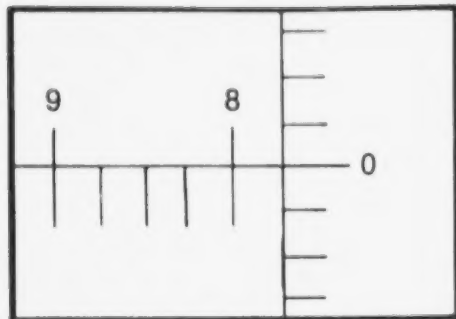
G104B-111

TM #42

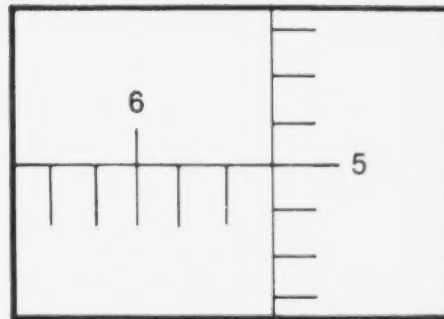
228

229

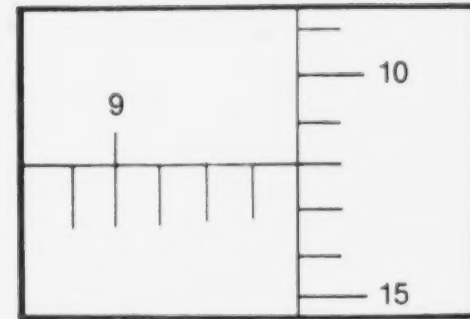
Depth Micrometer Readings



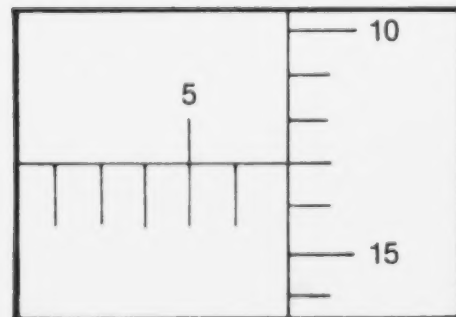
0.775



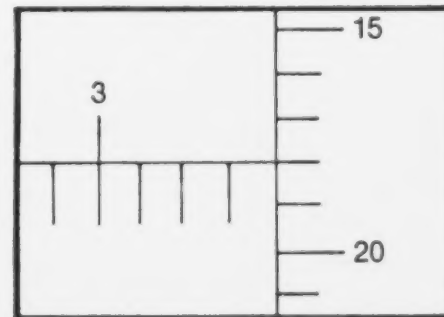
0.530



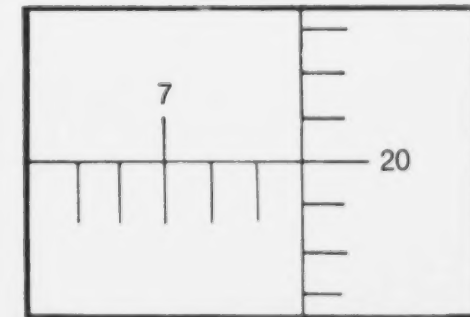
0.812



0.463



0.218



0.645

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TM #43

230

231

Depth Micrometer Sleeve Readings



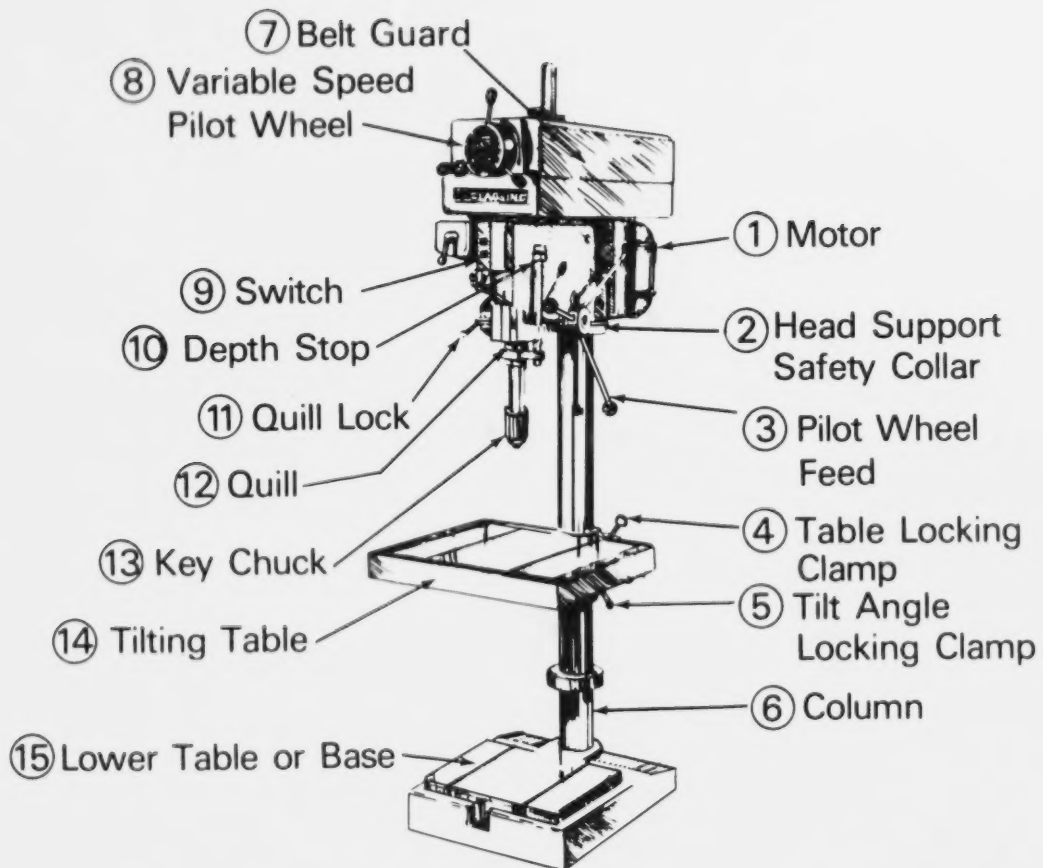
G104B-115

233

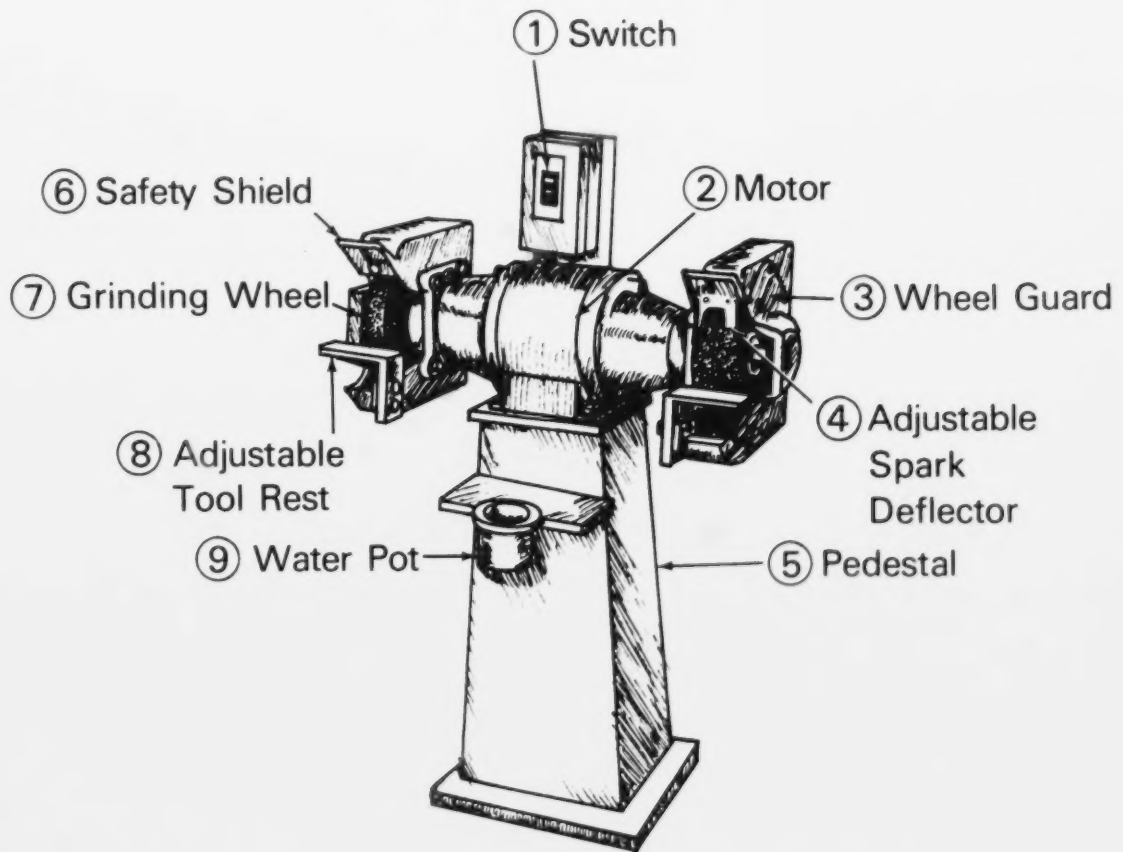
TM #44

232

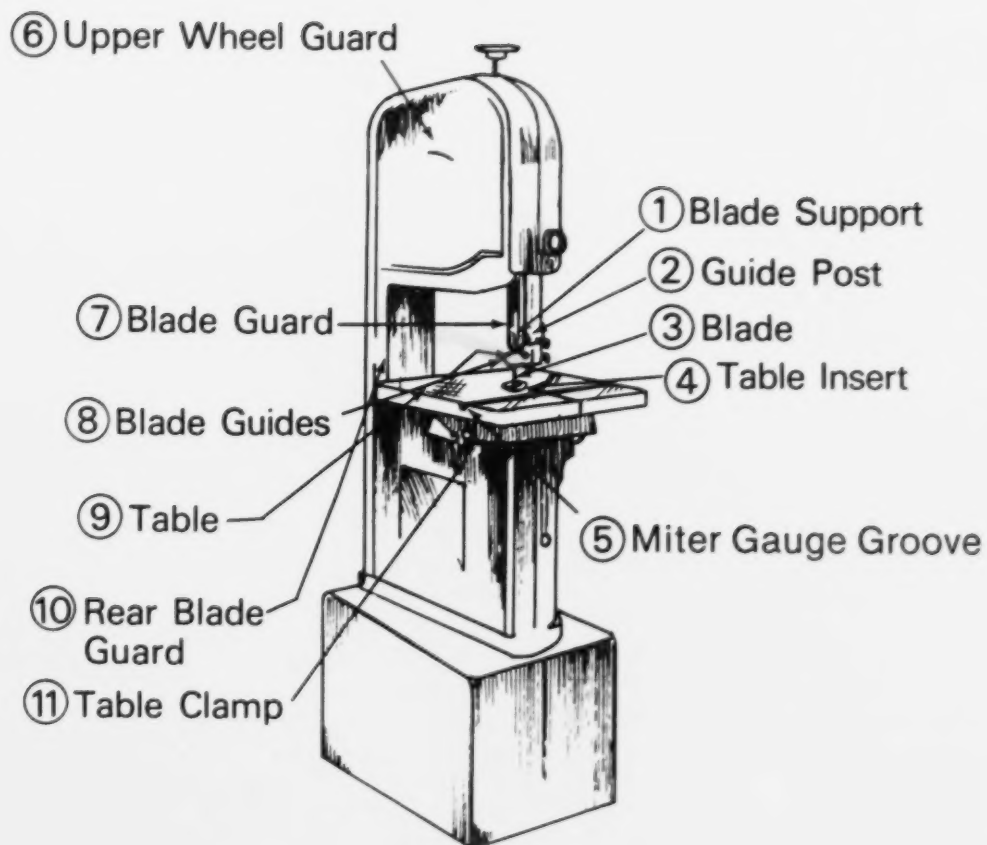
Parts of a Drill Press



Parts of a Bench Grinder



Parts of a Band Saw



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WORKBOOK SUPPLEMENT #1--Determine Tap and Body Drill Sizes

There are many times when the aviation technician finds it necessary to either repair an existing hole or to create a new one. Knowledge of which body drill or tap drill to use to prepare a hole is essential. The correct information can be located on the many charts available to use for these procedures. Refer to EA-ITP-G 5:II:55, Figure 2-49 to answer the following questions.

A. A number 10 body drill is used to prepare a hole for what size fastener?

B. Which tap drill size would be used to prepare a hole to be tapped for internal threads using a 4-48 tap? -----

C. What is the diameter of a body for thread of a 7/16-20 fastener?

D. What is the tap drill size for a 5/16-18 threaded hole? -----

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WORKBOOK SUPPLEMENT #2--Interpret the National Taper Pipe Thread Size Chart

Pipe threads are used in fluid line fittings. These types of fittings use a thread sizing chart which is somewhat different from the standard thread chart. The aviation technician must use this chart to select the appropriate tap drills for preparing these holes. It is important to be familiar with the relationship between tap drills, nominal sizes, and threads per inch used in the National Taper Pipe Thread Size Chart. Refer to EA-ITP-G 5:II:56, figure 251 to answer the following questions.

- A. What is the tap drill size for a 1/2-14 NPT fitting? _____
- B. How many threads would be found on a 3/4-inch pipe? _____
- C. What is the pipe OD when it has a nominal size of 1 inch? _____
- D. What is the tap drill size for a 3/4-14 NPT pipe thread? _____

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WORKBOOK SUPPLEMENT #3--Use a Rule

Steel scales or steel rules are found in almost all tool chests in both 6-inch and 12-inch lengths. The aviation maintenance technician will use either of these rules when the accuracy of a vernier or micrometer caliper is not needed. The steel rule is a very useful tool that can keep you from making mistakes if you learn how to read it quickly and accurately. The trained eye can be accurate to 0.005 of an inch. This workbook supplement will give you the opportunity to develop competency in the use of a rule.

PART I

Using a steel rule with $1/8"$, $1/16"$, $1/32"$, and $1/64"$ graduations, construct straight lines of the following lengths.

- A. $2 \frac{1}{4}"$
- B. $3 \frac{1}{2}"$
- C. $4 \frac{1}{8}"$
- D. $2 \frac{7}{8}"$
- E. $1 \frac{5}{16}"$
- F. $2 \frac{7}{32}"$
- G. $3 \frac{47}{64}"$
- H. $2 \frac{15}{16}"$
- I. $1 \frac{19}{32}"$
- J. $3 \frac{3}{64}"$

WORKBOOK SUPPLEMENT #3

PART II

Use a steel rule with $1/8"$, $1/16"$, $1/32"$, and $1/64"$ graduations, and measure the length of the following lines. Write your answers on the measuring lines.

(NOTE: Express each length in its simplest form.)

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

J. _____

WORKBOOK SUPPLEMENT #3

PART III

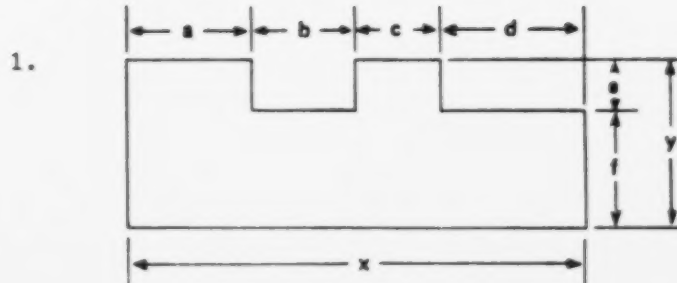
- A. Use the rule to measure each lettered dimension on the objects
- B. Use the finest 64ths graduation on the rule and reduce measure to lowest terms

EXAMPLE:

$$16/64" = 1/4"$$

- C. Indicate each measurement (in lowest terms) in the correct answer space

ANSWER



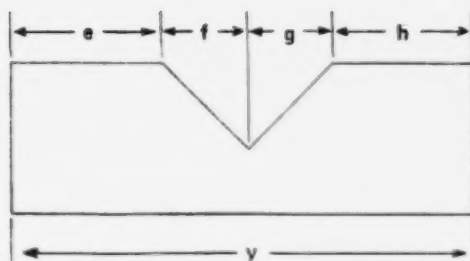
- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- x. _____
- y. _____



- k. _____
- l. _____
- m. _____
- z. _____

WORKBOOK SUPPLEMENT #3

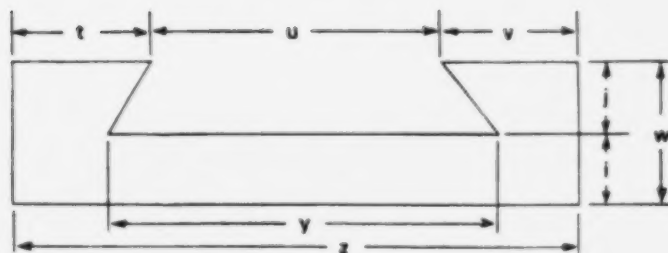
3.



ANSWER

e. _____
f. _____
g. _____
h. _____
y. _____

4.



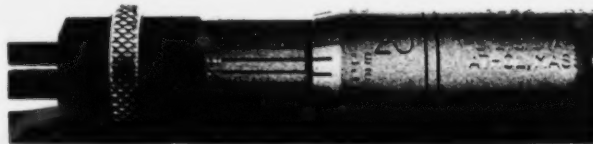
t. _____
u. _____
v. _____
y. _____
z. _____
j. _____
i. _____
w. _____

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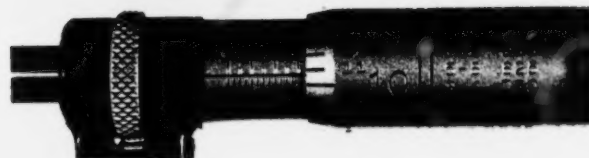
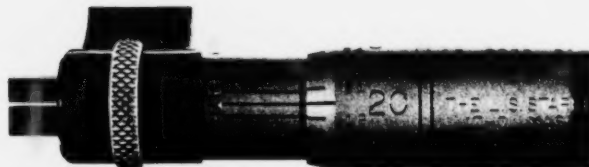
WORKBOOK SUPPLEMENT #4--Read Micrometer Settings

The precision measuring tool most universally used by the A&P technician is the micrometer caliper. These instruments are used to measure the thickness of sheet metal as well as to measure the fits of almost all the parts in an engine. Therefore, it is important for you to develop competency in reading the micrometer quickly and accurately. This workbook supplement will aid you in the development of this skill.

1. Record the reading of each of the following vernier micrometer settings in the spaces provided. Be sure to write the decimal point in the correct place.

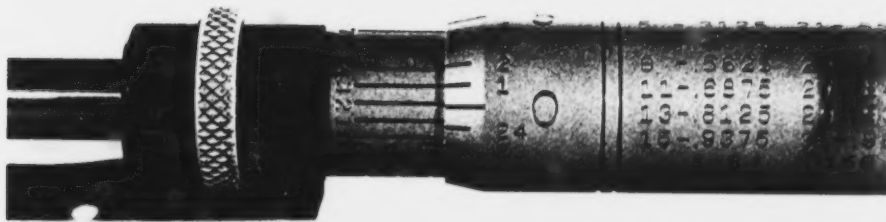


a. _____

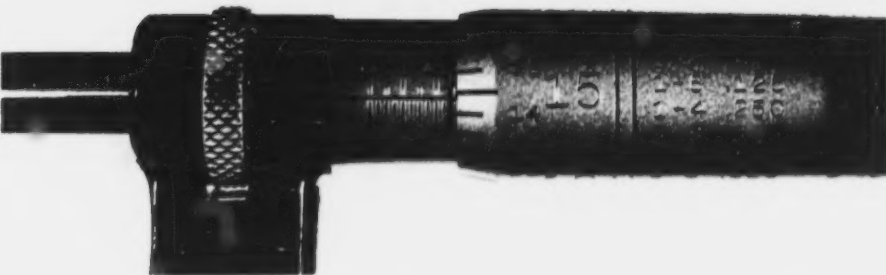
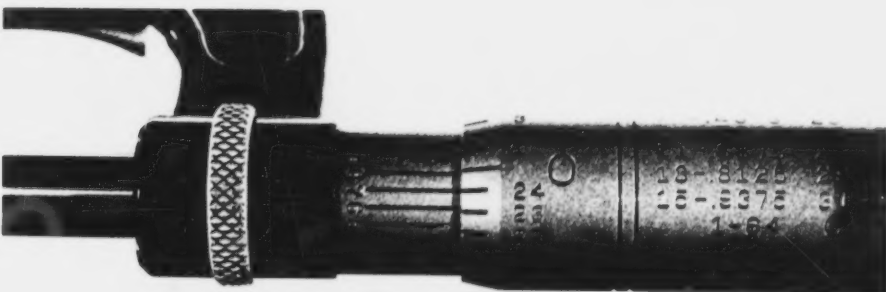


b. _____

WORKBOOK SUPPLEMENT #4



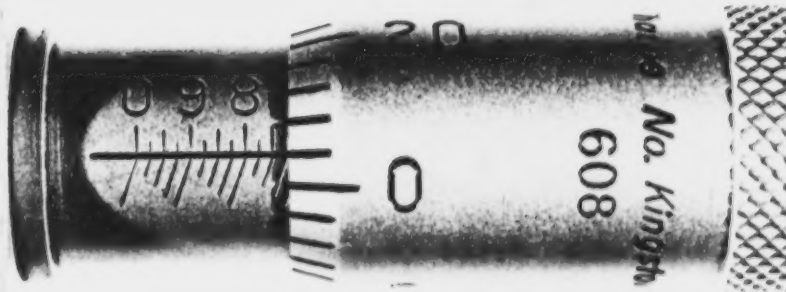
c. _____



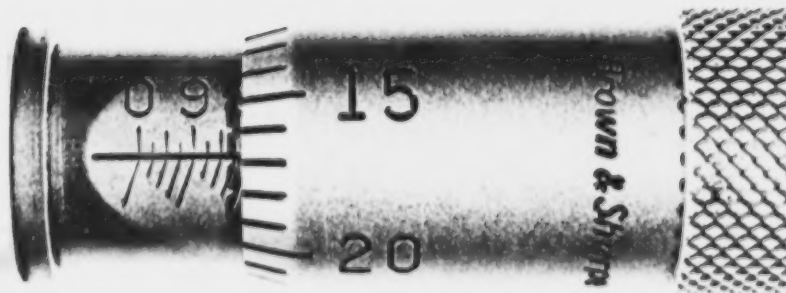
d. _____

WORKBOOK SUPPLEMENT #4

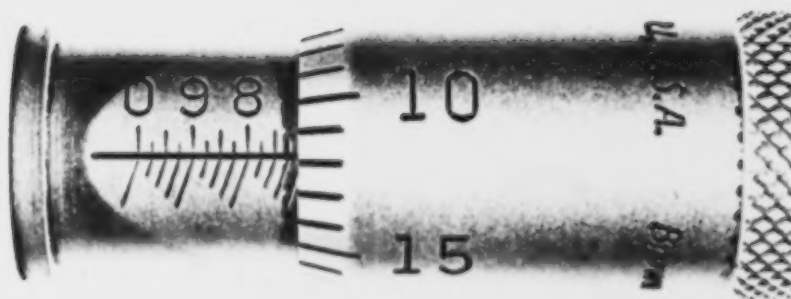
2. Record the reading of each depth micrometer setting in the spaces provided.



a. _____



b. _____



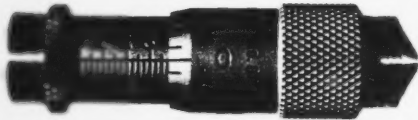
c. _____



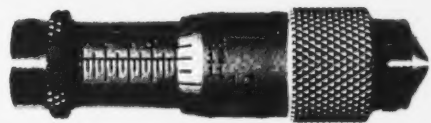
d. _____

WORKBOOK SUPPLEMENT #4

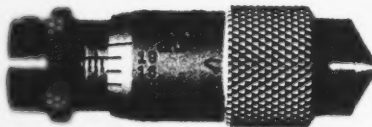
3. Record the reading of each inside micrometer in the spaces provided.



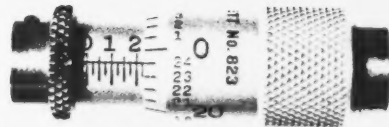
a.



b.



c.



d.

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ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #1

- A. 10-32
- B. #42
- C. 0.4375"
- D. #F

Workbook Supplement #2

- A. 23/32
- B. 14 threads
- C. 1.315 inches
- D. 59/64

Workbook Supplement #3

PART I--Evaluated to the satisfaction of the instructor

PART II

- A. 2 33/64"
- B. 1 29/64"
- C. 3 25/64"
- D. 2 9/16"
- E. 3 25/32"
- F. 2 27/64"
- G. 63/64"
- H. 1 29/32"
- I. 2 51/64"
- J. 2 3/64"

ANSWERS TO WORKBOOK SUPPLEMENTS

PART III

- | | | |
|-----------------|--------------|------------------------|
| 1. a. $23/32''$ | d. $53/64''$ | x. $2 \frac{39}{64}''$ |
| b. $19/32''$ | e. $19/64''$ | y. $31/64''$ |
| c. $31/64''$ | f. $43/64''$ | |
2. k. $3/32''$
- l. $2 \frac{9}{64}''$
- m. $43/64''$
- z. $2 \frac{29}{32}''$
3. e. $33/64''$
- f. $1/2''$
- g. $31/64''$
- h. $51/64''$
- y. $2 \frac{5}{8}''$
4. t. $51/64''$
- u. $1 \frac{21}{32}''$
- v. $25/32''$
- y. $2 \frac{11}{64}''$
- z. $3 \frac{15}{64}''$
- j. $13/32''$
- i. $13/32''$
- w. $13/16''$

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #4

- | | |
|--------------|-------------|
| 1. a. 0.3633 | 3. a. 1.224 |
| b. 0.3357 | b. 1.412 |
| c. 0.2454 | c. 1.094 |
| d. 0.2647 | d. 1.375 |
| 2. a. 0.724 | |
| b. 0.817 | |
| c. 0.712 | |
| d. 0.655 | |

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PROJECT GUIDE #1--Use the Micrometer Caliper

PURPOSE: The ability to use precision measuring instruments is necessary in today's aviation industry. This project guide will allow you to develop competency in the use of the vernier micrometer calipers.

REFERENCE MANUALS: None

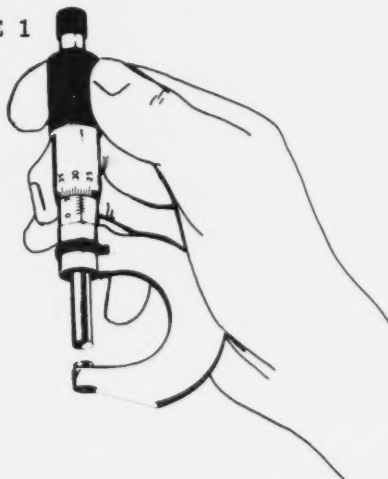
TOOLS AND EQUIPMENT:

- A. 1" vernier micrometer
- B. Dowel pins of assorted sizes with ends painted the following colors
 - 1. Red
 - 2. Blue
 - 3. Green
 - 4. Yellow
 - 5. Brown

PROCEDURE

- A. Grasp micrometer in right hand so the little finger is through the frame and the thumb and index finger are on the thimble (Figure 1)

FIGURE 1



PROJECT GUIDE #1

- B. Pick up the red dowel pin in left hand
- C. Adjust the micrometer by rotating the thimble clockwise or counter-clockwise so you can insert the dowel pin between the anvil and the spindle
- D. Rotate one revolution larger or counterclockwise
- E. Hold the dowel pin on the anvil and rotate the thimble clockwise until you feel a slight pressure or resistance to the thimble movement
- F. Read the scale on the micrometer and record your reading according to dowel pin colors provided below

(NOTE: Make sure the decimal point is in the proper place.)

EXAMPLE: Black 0.8125

Red	_____
Blue	_____
Green	_____
Yellow	_____
Brown	_____

- G. Return equipment and materials to instructor

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PROJECT GUIDE #2--Use the Inside Micrometer

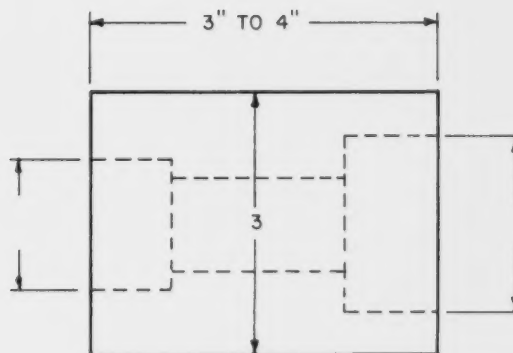
PURPOSE: As an aviation maintenance technician it will be necessary for you to take inside measurements. The inside micrometer is the precision measuring instrument used to perform this task. This project guide will allow you to develop competency in using the inside micrometer.

REFERENCE MANUALS: None

TOOLS AND EQUIPMENT:

- A. Inside micrometer with extension rods
- B. Surface plate
- C. Steel rule
- D. Steel pipe premachined on inside diameter
 - 1. 6-inch pipe; one end colored red, one end colored blue (Figure 2)

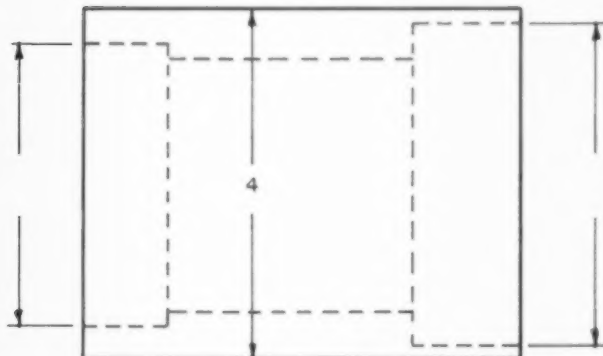
FIGURE 2



PROJECT GUIDE #2

2. 4-inch pipe; one end colored yellow, one end colored white (Figure 3)

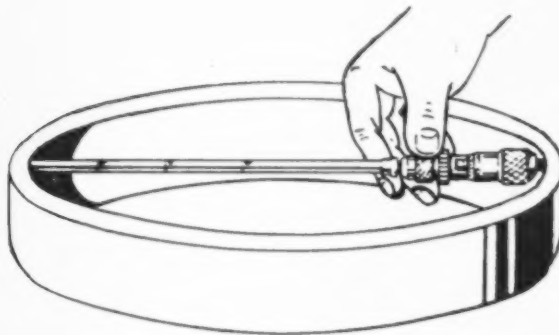
FIGURE 3



PROCEDURE:

- A. Place pipe, red end up, on clean surface plate
- B. Use steel rule to determine approximate inside diameter of pipe end
- C. Set up inside micrometer so that range is in that of the inside diameter
- D. Insert micrometer in pipe and adjust out until spindle and anvil make contact with the walls of the pipe; use both hands or extension handle if necessary (Figure 4)

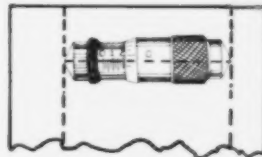
FIGURE 4



PROJECT GUIDE #2

- E. Keep ends of inside micrometer parallel to end of pipe and wiggle to make sure micrometer is at its maximum reading (Figure 5)

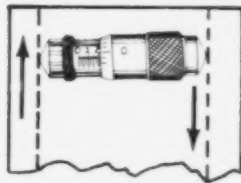
FIGURE 5



Ends Parallel to Ends of Pipe

- F. When you feel that micrometer is at its maximum reading, remove micrometer by pulling and pushing (Figure 6)

FIGURE 6



- G. Read the micrometer and add the length of micrometer plus extension rod
- H. Record reading
- (NOTE: Blanks for recording readings are found in Step K.)
- I. Repeat steps A through H to take measurement of blue end
- J. Using other pipe, repeat steps A through H to take measurement of yellow end

(NOTE: You must use a different extension rod.)

PROJECT GUIDE #2

K. Repeat steps A through H to take measurement of white end

Red

Blue

Yellow

White

L. Return equipment and materials to instructor

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PROJECT GUIDE #3--Use the Depth Micrometer

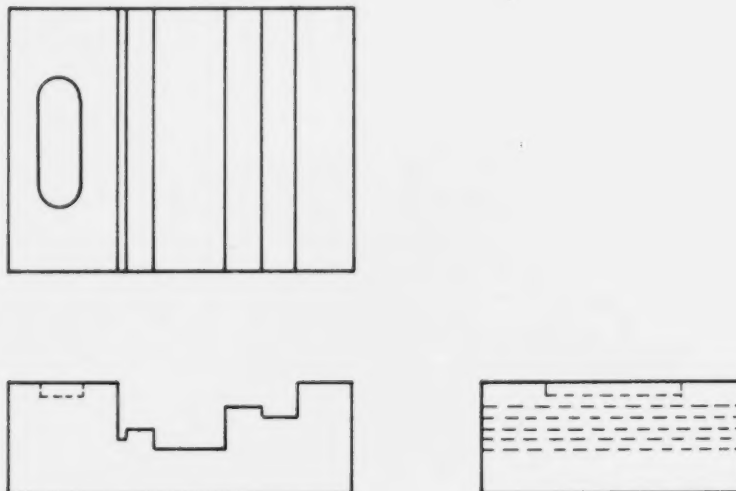
PURPOSE: The depth of grooves and recesses in a part can be accurately measured with a micrometer depth gage. As an aviation maintenance technician it is necessary that you develop competency in the use of the depth micrometer.

REFERENCE MANUALS: None

TOOLS AND EQUIPMENT:

- A. Depth micrometer with extension rods
- B. Surface plate
- C. Pre-machined steel or aluminum block (Figure 7)

FIGURE 7

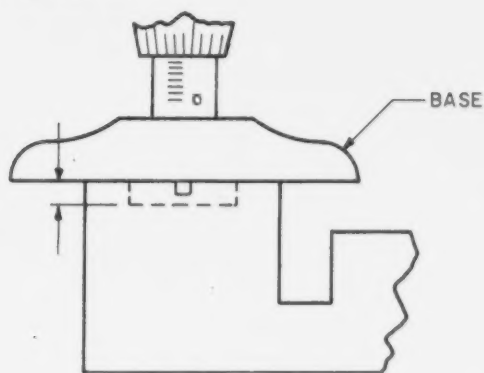


PROJECT GUIDE #3

PROCEDURE:

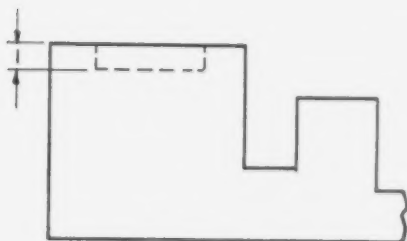
- A. Wipe surface plate with clean cloth to remove any dirt or dust
- B. Wipe off block and place on surface plate with slots up
- C. Place depth micrometer base on part so depth of milled slot can be recorded (Figure 8)

FIGURE 8



- D. Hold the base down firmly with left hand and turn the thimble with the thumb and index finger of the right hand until you feel the spindle make contact with the bottom of the recess (Figure 9)

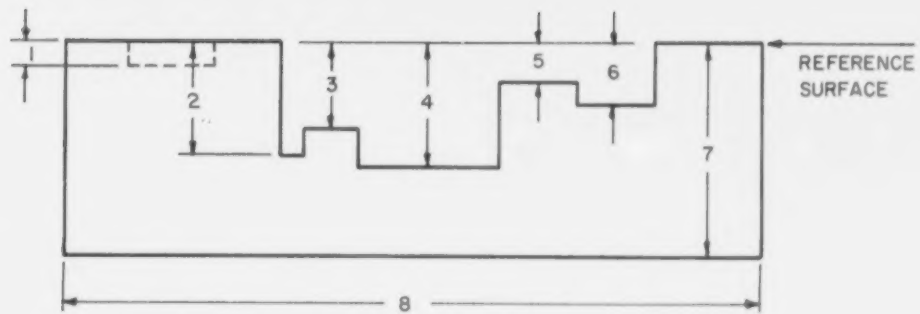
FIGURE 9



PROJECT GUIDE #3

E. Use depth micrometer to measure and record each reading (Figure 10)

FIGURE 10



- | | | | |
|----|-------|----|-------|
| 1. | _____ | 5. | _____ |
| 2. | _____ | 6. | _____ |
| 3. | _____ | 7. | _____ |
| 4. | _____ | 8. | _____ |

F. Return equipment and materials to instructor

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PROJECT GUIDE #4--Use Vernier Caliper to Take Inside, Outside, and
Depth Measurements

PURPOSE: Vernier calipers are used to make accurate inside or outside measurements faster than can be made with a micrometer caliper and for making measurements that exceed the practical range of a micrometer. This project guide will allow you to develop competency in the use of the vernier caliper to take inside, outside, and depth measurements.

REFERENCE MANUALS: None

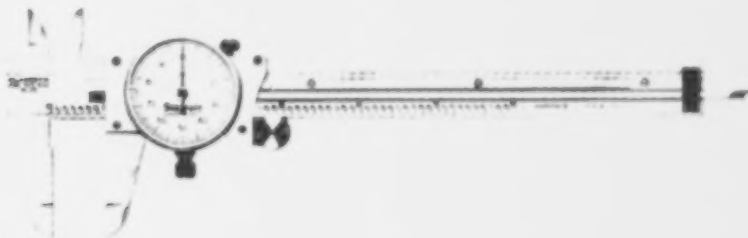
TOOLS AND EQUIPMENT:

- A. 6-inch or 8-inch universal vernier caliper
- B. Premachined steel bar turned with four dimensions
- C. Premachined steel, drilled and bored

PROCEDURE:

(NOTE: Some vernier calipers have a dial. The application and use is the same as the universal vernier caliper, but the dial makes it easier and faster to read. See Figure 11.)

FIGURE 11



Used with permission of the L.S. Starrett Company.

I. Procedure for taking inside measurements

- A. Grasp the vernier caliper in the right hand with vernier scale up
- B. Grasp part to be measured with left hand

PROJECT GUIDE #4

- C. Use the thumb of the right hand to adjust caliper so inside portion of vernier will slide in bore, then open the jaw by sliding the slide toward your right until you feel a slight amount of pressure; take reading before moving from part (Figures 12 and 13)

FIGURE 12

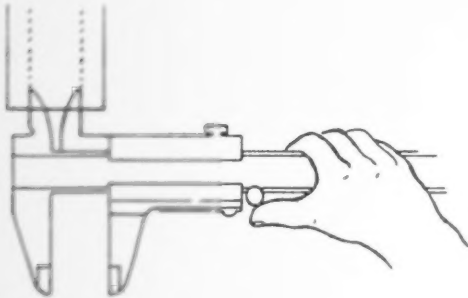
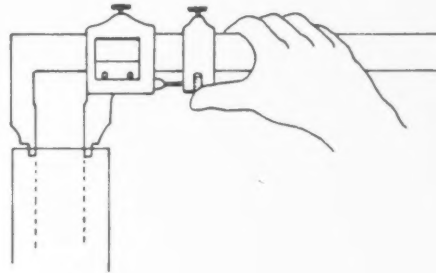
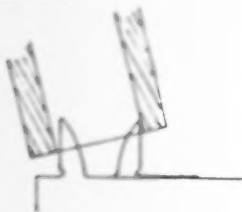


FIGURE 13



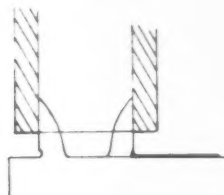
(NOTE: Be careful not to apply too much pressure, but keep the jaws squarely in the bore. See Figures 14 and 15.)

FIGURE 13



Incorrect Position

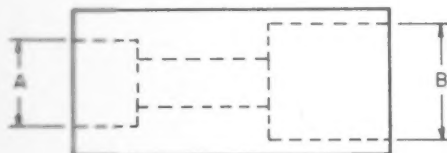
FIGURE 14



Correct Position

- D. Measure each of the inside bores and record your readings (Figure 16)

FIGURE 16

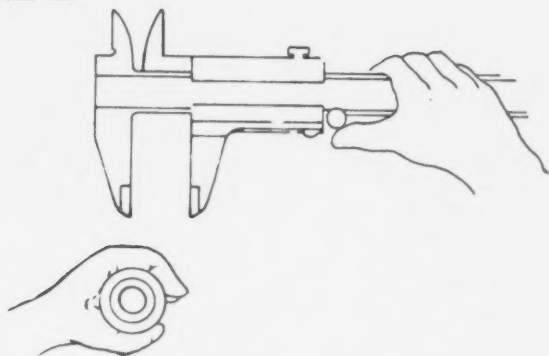


PROJECT GUIDE #4

II. Procedure for taking outside measurements

- A. Pick up the vernier caliper with your right hand so you are looking at the vernier scale
- B. Grasp the part to be measured parallel to your body in your left hand (Figure 17)

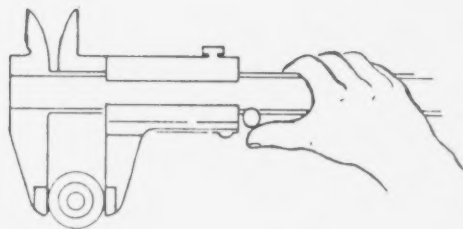
FIGURE 17



(NOTE: The thumb of the right hand can slide the sliding member along the beam of the vernier.)

- C. Place the part between the two jaws close to beam, if possible; move the sliding member against the part by applying slight pressure with the thumb; take reading before removing part (Figure 18)

FIGURE 18

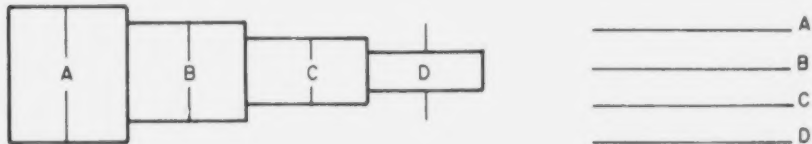


(CAUTION: Do not apply so much pressure that you spring the caliper.)

PROJECT GUIDE #4

- D. Start measuring at one end and work toward the other (see Figure 19); write each dimension in the spaces provided

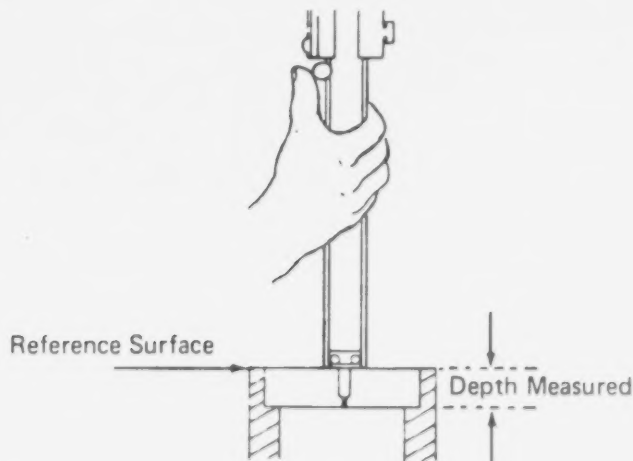
FIGURE 19



III. Procedure for taking depth measurements

- A. Place the part to be measured on the bench with the deeper bore resting on the table
- B. Grasp the vernier caliper and place the base of the beam on the reference surface
- C. Using one hand to hold the caliper perpendicular to the reference surface, use the free hand to move the slide down until you feel the blade make contact with the lip or surface to be measured; take measurement before removing part (Figure 20)

FIGURE 20



- D. Record your reading _____ a

PROJECT GUIDE #4

- E. Turn part end for end and measure the depth of the bore on the other end; record your reading _____ b
- F. Return equipment and materials to instructor

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PROJECT GUIDE #5--Use Hand and Power Tools

PURPOSE: This project is to prepare the student to use basic hand and power tools. This project will allow the student to develop skill in many of the mechanical processes used on aircraft structures. The list of these processes will include squaring, filing, drilling, counter-sinking, counterboring, reaming, and many other tasks which are routine to the aviation maintenance technician.

REFERENCE MANUALS:

- A. AC-65-9A, Chapter 12
- B. EA-ITP-G 5:II
- C. Standard Aircraft Handbook

EQUIPMENT AND TOOLS NEEDED:

- A. Combination square head and blade
- B. Pocket scribe
- C. Center punch
- D. 10-inch hand file (double cut)
- E. Hacksaw with appropriate blade pitch
- F. Ball peen hammer
- G. 10-inch mill file (single cut)
- H. Duckbill pliers
- I. Bench vise
- J. Project kit
 - 1. Number drills
 - a. 30
 - b. 3
 - c. 50

PROJECT GUIDE #5

2. Letter drills
 - a. F
 - b. U
 - c. Q
3. Fractional drills
 - a. 31/64
 - b. 7/16
 - c. 25/64
 - d. 1/4
 - e. 5/16
 - f. 1/8
4. Drill gages
5. Drill vise and backup block
6. Drill press
7. 82° countersink
8. 3/8" counterbore with 1/4" pilot
9. Taper pin reamer with #4 Morse taper
10. Tap handles (large and small)
11. 1/2-inch high-speed machine reamer
12. 5/16-18 NC taper tap
13. 7/16-14NC taper tap
14. 7/16-20NF taper tap
15. 1/4 NPT tap
16. 1/4 NPT reamer
17. 3/8-24NF taper tap
18. Die stock
19. 7/16-20NF die (adjustable)

SUPPLIES AND MATERIALS:

- A. Cold rolled steel or aluminum block (1/2" x 2" x 3 5/16")
(Aluminum is recommended)
- B. Cutting oil
- C. Layout stain

PROJECT GUIDE #5

- D. #4 taper pin (1")
- E. AN505-516-30
- F. 7/16" rod (2" long)
- G. 6-inch piece of 0.032 safety wire

PROCEDURE: (NOTE: Your instructor will demonstrate all processes used in this project before you attempt any of the specific steps.)

(CAUTION: Before performing, read each procedure thoroughly.)

- A. Check the aluminum or steel block to see which end is closest to square, and then square that end of the block using the hand and mill files.

(NOTE: Maintain a close check on the squareness of the block as you are working.)

- B. Lay out the length line for the block using the square end as your starting point; use the layout stain to make surface easy to mark, and lay out the dimension of the line according to the information in Sketch #1 (at the end of this project guide)

- C. Cut a small distance outside the layout line with the hacksaw

- D. Use both your hand and mill files to file the block to proper size

(NOTE: Continually check the squareness of the block to both width and thickness.)

- E. Reapply layout stain as necessary, and then lay out the positions of the holes according to the dimensions on Sketch #1
- F. Locate the hole positions at the intersections of the layout lines and mark with center punch
- G. Select a #30 drill and install it securely in the drill press chuck

(CAUTION: Use at least two holes when tightening a keyed chuck.)

- H. Clamp the block securely in the drill press vise

(CAUTION: Be sure to install the backup block beneath the block to be drilled. This will ensure that you will not drill into the vise and that the material will be level when the drilling operation is performed. Double-check your block with the spirit level in your combination square head before you start any drilling.)

PROJECT GUIDE #5

- I. Position the drill press vise and work under the drill press before turning power on

(CAUTION:

1. Make sure the power speed is set on the drill press belt and pulley
2. Do not overheat the drill bit. Overheating could be the result of using too little feed pressure or not enough cutting oil
3. Do not allow the drill to become loose in the chuck
4. Never use excess feed pressure if the drill is not cutting properly)

- J. Turn the drill press motor on and pilot drill all hole positions

(NOTE: Hold the vise firmly with your left hand, and apply a medium pressure to the drill feed handle with your right hand.)

(CAUTION: Do not turn loose of the drill vise while feeding the drill.)

- K. Apply cutting oil liberally during the drilling process
- L. As the drill nears the opposite side of the block, reduce the pressure on the feed handle; feed carefully until the drill breaks out of the block
- M. Final drill holes using equipment specified in instruction sheet for Holes #1-#8, letters A-H, #1 and according to Sketch #2 (these are found at the end of this project guide)
- N. Clean the drills, drill press vise, and drill table when this portion of the project is complete. Return drills to project kit
- O. Set the drill press belt and pulleys to slow speed
- P. Install the 82° countersink securely in the drill press vise
- Q. Recheck the block for security in the vise and check the level of the block with the spirit level in the combination square head
- R. Position the work under the countersink in the drill press chuck as specified in Sectional View XX of Sketch #2; turn drill press on

S. Countersink the hole

(CAUTION: Do not turn loose of the vise while applying pressure to the feed handle.)

(NOTE: Remember to hold the vise with your left hand and the feed handle with your right hand. Feed the countersink using a medium pressure. Use cutting oil liberally, and check the depth of the countersink frequently. The depth of the countersink can be checked by measuring the width of the countersink hole with the AN505-516-30 screw turned upside down. When the head of the screw precisely fits the hole, the depth is correct.)

- T. Turn off drill press and remove the countersink from the drill press
- U. Set the drill press for slow speed, and install the counterbore in the drill press chuck
- V. Recheck the security of the work in the drill press vise and position the block under the counterbore as specified in Sketch #2, Hole #3
- W. Set the depth gage of the drill press; use the dimension given in Sketch #2, Sectional View XX
- X. Turn the drill press on and with medium feed pressure counterbore the block
- Y. Clean the drill press, vise, and drill table, return countersink to project kit
- Z. Select the proper reamers for Holes #2, #5, and #7 as specified on the Instruction Sheet

(NOTE: Observe the following precautions while reaming.)

- 1. Never turn a reamer backwards. This will cause the cutting edges to become dull. Always turn the reamer in a clockwise direction when cutting or removing the reamer
- 2. Never use a hand reamer in a power tool
- 3. Always use cutting oil
- 4. Always check reamers with a micrometer to verify size
- AA. Ream Hole #2 with the 1/2-inch machine reamer as specified in Sketch #2
- BB. Ream Hole #5 with the 1/4 NPT machine reamer as specified in Sketch #2

PROJECT GUIDE #5

CC. Ream Hole #7 with the #4 Morse taper reamer as specified in Sketch #2

1. Select the proper reamer and install in the tap handle
2. Ream the hole until the large end of the taper pin protrudes $1/4$ to $5/16$ inch from the block with the small end protruding slightly less (See Figure 7, page 28 of the Standard Aircraft Handbook)
3. With the taper pin installed in the block, drill a hole in the pin using a #50 drill and drilling perpendicular to the centerline of the pin as in Figure 7, page 28 of the Standard Aircraft Handbook
4. Drill two holes in the block with a $1/8$ " drill approximately $1/8$ inch from the edge of the hole
5. Install safety wire as in Figure 7, page 28 of the Standard Aircraft Handbook, using the holes you have drilled in the block and the taper pin

DD. Select taps; tap Holes #1, #4, #5, #6, and #8 according to Sketch #2 and Instruction Sheet

(NOTE: Follow general tapping precautions listed below.)

1. Holes prepared for tapping must be correct size
2. Do not attempt to cut threads in hardened material
3. Use extra caution on small taps
4. Align tap carefully or a broken or chipped tap will result
5. On blind holes drill sufficiently deep so there will be room in the hole for chips, and remove chips before using final bottoming taps

(NOTE: Hand tap holes using the following procedures.)

1. Make sure the work is clamped tightly in the bench vise
2. Check to see that the work is level in the bench vise
3. Select the correct tap and install in the tap wrench (tap handle)

4. Start tap in hole by turning in clockwise direction two to three turns
 5. Remove tap wrench and check tap for squareness using your combination square head

(NOTE: If tap is not square, straighten in the next one or two turns.)
 6. Reverse the tap $1/4$ turn every $1/2$ turn to clear the chips from the threads
 7. Apply cutting oil liberally.
- EE. Clean all tools and work area before continuing, return reams and taps to project kit
- FF. Chamfer the ends of the 7/16-inch rod using your mill file
- GG. Clamp one end of the rod vertically in the bench vise
- HH. Select the 7/16-20NF die and install in the die stock
- II. Adjust the die to make a shallow cut

(NOTE: Turn adjusting screw $1/4$ to $1/2$ turn each to adjust for each cut. The finished threads will produce a class 3 fit.)
- JJ. After the die is adjusted, begin to cut the threads into the rod

(NOTE: Use plenty of cutting oil and cut slowly.)
- KK. Reverse the die $1/4$ turn every one or two turns to allow the chips to fall away from the threads
- LL. After 1 inch of thread has been cut on rod, back die off stud and check to see if proper fit has been obtained
- MM. Repeat steps II through LL until proper fit is obtained

(NOTE: Fit will be checked by inserting stud into Hole #8 in block. It is quite possible that three cuts may be needed to establish proper fit. A class 3 fit is a medium fit. This is the tightest fit possible without having to use a wrench to install the stud.)

PROJECT GUIDE #5

NN. Clean up your work area and tools; return all tools to project kit

OO. Have your instructor evaluate your work

PP. Return all tools and equipment when told to do so by instructor

PROJECT GUIDE #5--Operation List

The following list identifies all operations to be performed in this project guide

A. Hole #1

1. Drill F
2. Counter 82 degrees
3. Tap 5/16-18NC

B. Hole #2

1. Drill 31/64
2. Machine ream to 0.500" plus .002"

C. Hole #3

1. Drill 1/4
2. Counterbore 3/8"

(NOTE: Counterbore will have a 1/4 pilot.)

D. Hole #4

1. Drill U
2. Tap 7/16-14NC

E. Hole #5

1. Drill 7/16
2. Ream 1/4 National Pipe
3. Tap 1/4 NPT

F. Hole #6

1. Drill Q
2. Tap 3/8-24NF

G. Hole #7

1. Drill #3
2. Ream with #4 taper pin ream

PROJECT GUIDE #5--Operation List

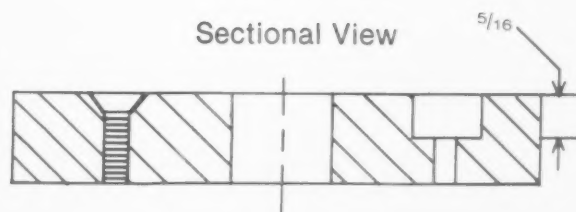
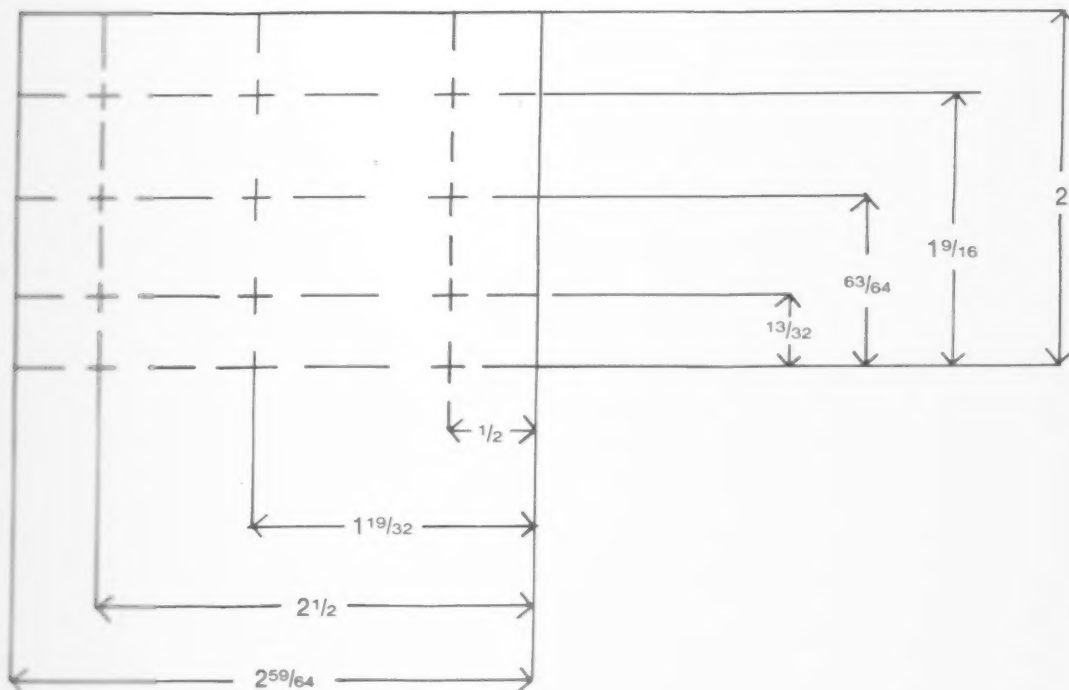
H. Hole #8

1. Drill 25/64
2. Tap 7/16-20NF

I. Hole #9

Drill two 1/8 holes at 1/8 inch distance from the edge of hole as indicated in Sketch #2

Sketch #1



(NOTE: These are not to be considered as scale drawings.)



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THEORY TEST

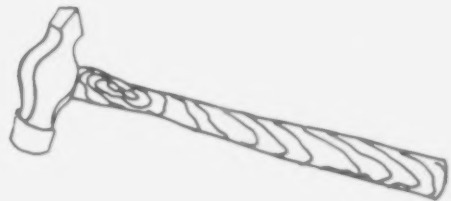
1. State seven guidelines for care and safe use of hand tools. Write the correct answers in the blanks.

a. _____
b. _____
c. _____
d. _____
e. _____
f. _____
g. _____

2. Identify the following types of hammers. Write the correct answers in the blanks.



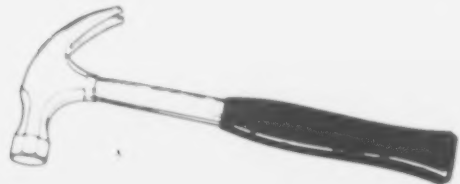
a. _____



b. _____



c. _____



b. _____

THEORY TEST



e. _____



f. _____



g. _____

3. Match types of hammers to their correct uses. Write the correct numbers in the blanks. Some blanks may have more than one correct answer.

- _____ a. Used to peen over rivets in commercial sheet metal work and to pound on hardened steel
- _____ b. Used to bend or straighten a rolled edge of a piece of metal
- _____ c. Used to drive and pull nails
- _____ d. Used for heavy pounding operations such as driving stakes
- _____ e. Used to smooth out sheet metal during forming procedures
- _____ f. Used to form and shape soft aluminum alloy

- 1. Mallet
- 2. Body hammer
- 3. Ball peen hammer
- 4. Claw hammer
- 5. Cross peen hammer
- 6. Sledgehammer
- 7. Staight peen hammer

THEORY TEST

4. Identify the following types of punches. Write the correct answers in the blanks.



a. _____



b. _____



c. _____



d. _____



e. _____

5. Match types of punches to their correct uses. Write the correct numbers in the blanks.

_____ a. Used to make an identification in the metal where a hole is to be drilled

1. Starting punch

2. Pin punch

_____ b. Used to start a fastener from its hole

3. Center punch

4. Prick punch

_____ c. Used to punch a rivet shank from its hole

5. Transfer punch

_____ d. Used to mark rivet holes when using an old skin as a template for laying out a new skin

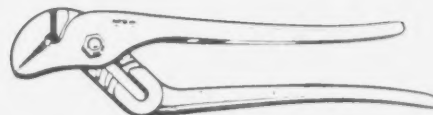
_____ e. Used to transfer dimensions and locations onto the metal to be drilled

THEORY TEST

6. Identify the following types of pliers. Write the correct answers in the blanks.



a. _____



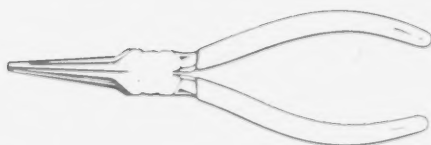
b. _____



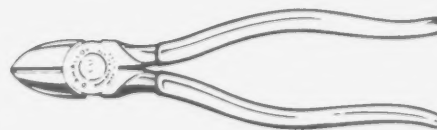
c. _____



d. _____



e. _____



f. _____



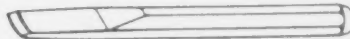
g. _____

THEORY TEST

7. Match types of pliers to their correct uses. Write the correct numbers in the blanks.

- | | |
|---|---------------------------------|
| _____ a. Used to tighten the packing gland nut around a water pump shaft | 1. Slip-joint pliers |
| _____ b. Most commonly used holding tool | 2. Diagonal cutters |
| _____ c. Used to clip safety wire after it has been twisted | 3. Duckbill pliers |
| _____ d. Used to twist safety wire | 4. Safety-wire cutters/twisters |
| _____ e. Used to hold pipes, cut wires, and pinch off hoses; some forms are used for sheet metal bending and as welding clamps and C-clamps | 5. Waterpump pliers |
| _____ f. Used in electrical and electronic work to grip and hold small components and wires while they are being installed or removed | 6. Needle-nose pliers |
| _____ g. Used to twist and cut wire | 7. Vise-grip pliers |

8. Identify the types of chisels most often used by the aviation technician. Write the correct answers in the blanks.



a. _____



b. _____

THEORY TEST



c. _____



d. _____

9. Match types of chisels to their correct uses. Write the correct numbers in the blanks.

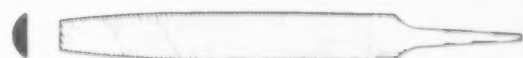
- _____ a. Most common type of chisel used by aviation technicians to cut or chip metal
- _____ b. Used to cut keyways and channels and to knock off the heads of rivets after the head has been drilled through
- _____ c. Used to cut V-grooves and sharp corners in square or rectangular grooves

- 1. Cape chisel (single and double bevel)
- 2. Diamond-point chisel
- 3. Flat or cold chisel

10. Identify the following types of files. Write the correct answers in the blanks.



a. _____



b. _____

THEORY TEST



c. _____



d. _____



e. _____



f. _____



g. _____



h. _____

11. Match types of files to their correct uses. Write the correct numbers in the blanks.

_____ a. Used for smoothing flat surfaces

1. Wood rasp

_____ b. Used to remove wood when it is not practical to use a saw or plane

2. Round file

_____ c. Used for filing sharp corners in grooves and keyways and for filing teeth of hand saws

3. Knife file

_____ d. Used to produce a smooth finish on the surface of the material being filed

4. Three square/ triangular file

_____ e. Used for filing small round holes and for cutting a radius in a groove or keyway

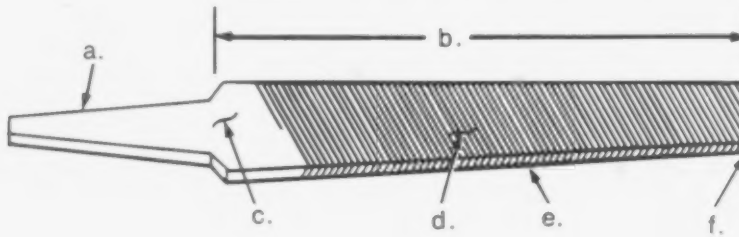
5. Hand file

_____ f. Used for filing acute angles

6. Vixen file

THEORY TEST

12. Label the parts of a file. Write the correct answers in the blanks.

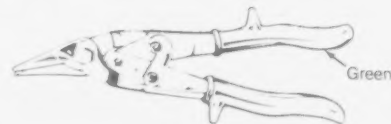
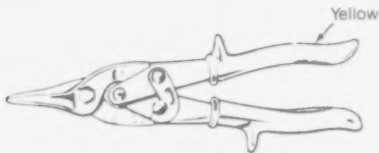


- | | |
|----------|----------|
| a. _____ | d. _____ |
| b. _____ | e. _____ |
| c. _____ | f. _____ |

13. Select true statements related to the cut and proper usage of files. Circle the letter before each correct statement.

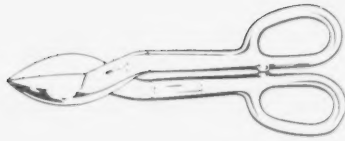
- Teeth of a single-cut file are cut at an angle of 65 and 85 degrees
- Double-cut files have two rows of teeth, one set at a 45-degree angle and the other set between a 70-degree and 80-degree angle
- When filing hard metal, apply pressure only during the backward stroke
- Files should be stored so they will not come in contact with other files
- Files should be cleaned with oil to prevent rusting
- Match the length and cut of the file with the type of material being cut and with the finish that is required

14. Identify the following types of shears. Write the correct answers in the blanks.

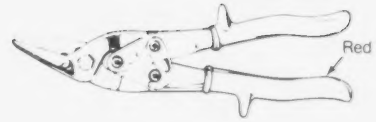


- | | |
|----------|----------|
| a. _____ | b. _____ |
|----------|----------|

THEORY TEST

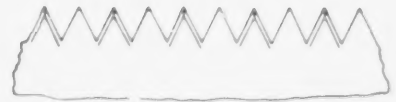


c. _____

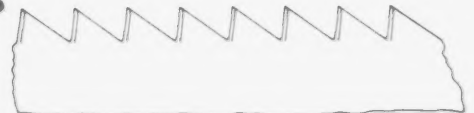


d. _____

15. Identify the following types of saws. Write the correct answers in the blanks.



a. _____



b. _____



c. _____

THEORY TEST



d. _____



e. _____

16. Match types of saws to their correct uses. Write the correct numbers in the blanks.

- | | |
|---|-----------------|
| _____ a. Used to cut metal | 1. Ripsaw |
| _____ b. Used for cutting precision parts | 2. Hacksaw |
| _____ c. Used for cutting across the grain of wood | 3. Keyhole saw |
| _____ d. Used to cut a large hole from a small hole | 4. Backsaw |
| _____ e. Used to cut with the grain of the wood | 5. Crosscut saw |

17. Select true statements related to the construction of saws. Circle the letter before each correct statement.

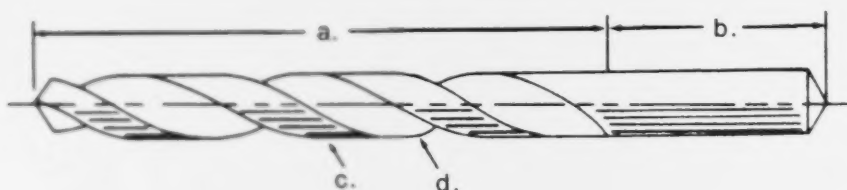
- a. Teeth of a rip saw act as a chisel to dig out the wood
- b. Blades of the keyhole saw range from 12 teeth per inch for cutting plastic to 14 teeth per inch for cutting wood
- c. If the work is wide and not too hard, a hacksaw blade should have as few teeth as possible to cut it
- d. Rip saws have more teeth than crosscut saws

THEORY TEST

18. List the two types of bits used for boring holes in wood. Write the correct answers in the blanks.

- a. _____
- b. _____

19. Label the parts of a twist drill. Write the correct answers in the blanks.



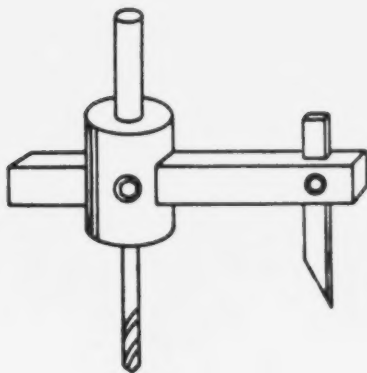
- a. _____ c. _____
- b. _____ d. _____

20. Select true statements related to the sizes, points, and uses of twist drills. Circle the letter before each correct statement.

- a. Number drills range in size from 0.0135 for the number 80 drill to 0.2280 for the number one drill
- b. Letter drill sizes are all smaller than number drills
- c. Fraction drills are available from 1/64 inch to 1/2 inch
- d. A drill must be ground so that its two cutting edges, or lips, are exactly the same length and meet in the exact center of the drill
- e. When drilling steel the drill is usually not lubricated
- f. The harder the material, the faster the drill must be turned
- g. Cutting edges of a drill are ground at an angle of 59 degrees from the central axis of the drill

THEORY TEST

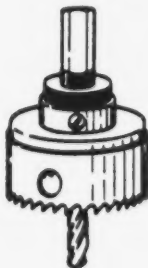
21. Identify the four types of hole cutters. Write the correct answers in the blanks.



a. _____

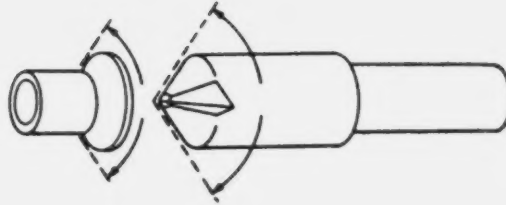


b. _____



c. _____

THEORY TEST

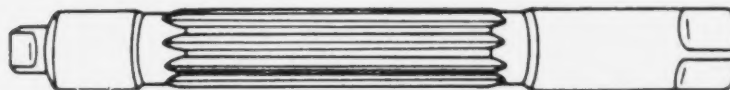


d. _____

22. Identify the four types of reamers. Write the correct answers in the blanks.



a. _____



b. _____



c. _____

THEORY TEST



d. _____

23. State the purpose of taps.

24. Match the descriptions of the five types of thread fits to their correct classes. Write the correct numbers in the blanks.

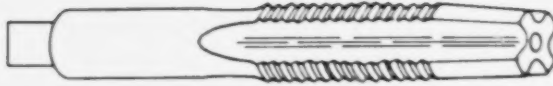
- | | |
|--|----------------|
| _____ a. Loose fit; used where ease of assembly is the major concern | 1. Class 1 fit |
| _____ b. Wrench-tight or interference fit | 2. Class 2 fit |
| _____ c. Medium fit; fine balance between a precision fit and one that is practical and economical in production | 3. Class 3 fit |
| _____ d. Free fit; standard for noncritical screw products | 4. Class 4 fit |
| _____ e. Snug fit that may require selective assembly to get parts that will screw together without using a wrench | 5. Class 5 fit |

25. Determine tap and body drill sizes.

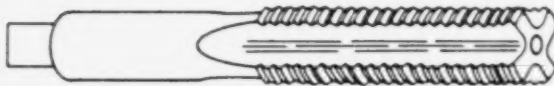
(NOTE: Test question 25 is a workbook supplement. It is an important part of this test. If it has not been completed, check with your instructor.)

THEORY TEST

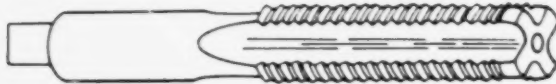
26. Identify the three types of hand taps. Write the correct answers in the blanks.



a. _____



b. _____



c. _____

27. Interpret the National Taper Pipe Thread Size Chart.

(NOTE: Test question 27 is a workbook supplement. It is an important part of this test. If it has not been completed, check with your instructor.)

28. State the purpose of dies.

THEORY TEST

29. List the two types of dies most often used by the aviation maintenance technician.

a. _____

b. _____

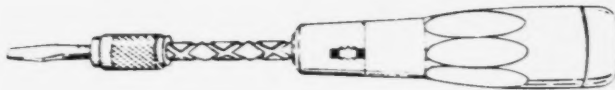
30. Identify the following types of screwdrivers. Write the correct answers in the blanks.



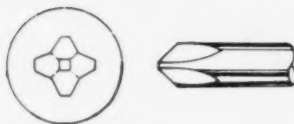
a. _____



b. _____



c. _____



d. _____

THEORY TEST



e. _____



f. _____



g. _____

31. Identify the following types of wrenches. Write the correct answers in the blanks.



a. _____

THEORY TEST



b. _____



c. _____



d. _____



e. _____

THEORY TEST

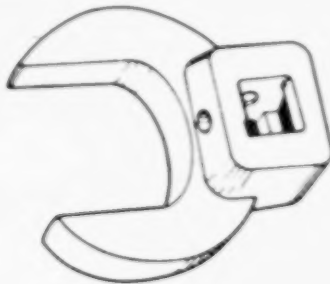


f. _____

32. Identify the following types of sockets. Write the correct answers in the blanks.



a. _____



b. _____

THEORY TEST



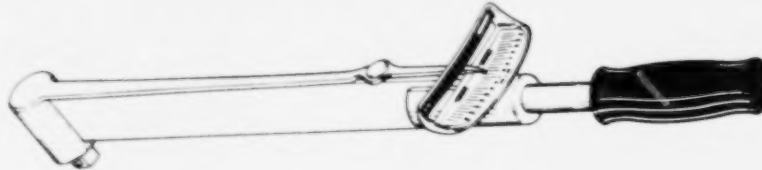
c. _____

33. Describe how to use a hand impact tool.

34. Explain the disadvantages of an impact wrench.

THEORY TEST

35. Identify the three basic types of torque wrenches most used in aviation maintenance. Write the correct answers in the blanks.



a. _____



b. _____



c. _____

36. Name the three units of measure to which torque wrenches are calibrated.

a. _____

b. _____

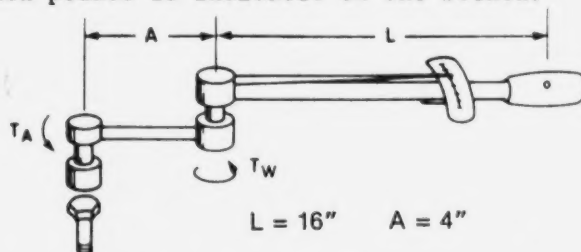
c. _____

37. State the formula used to determine the amount of torque to be used when an adapter is added to the torque wrench.

THEORY TEST

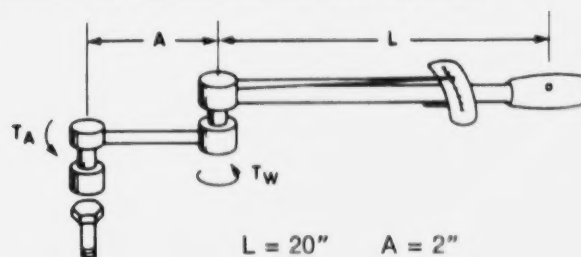
38. Determine the force to be applied to the fastener by a torque wrench in the following problems. Write the correct answers in the blanks.

- a. Find the force applied to the fastener by this torque wrench when 200 inch-pounds is indicated on the wrench.



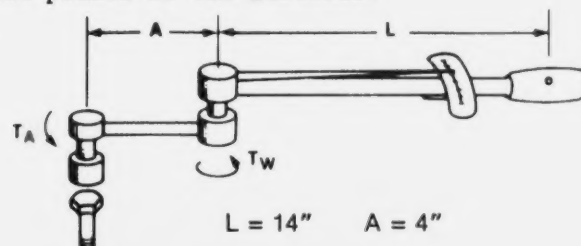
Force applied to the fastener is _____ inch-pounds

- b. Find the force applied to the fastener by this torque wrench when 360 inch-pounds is indicated on the wrench.



Force applied to the fastener is _____ inch-pounds

- c. Find the indication required on the torque wrench to get a torque of 360 inch-pounds at the fastener.



Torque required on the wrench is _____ inch-pounds

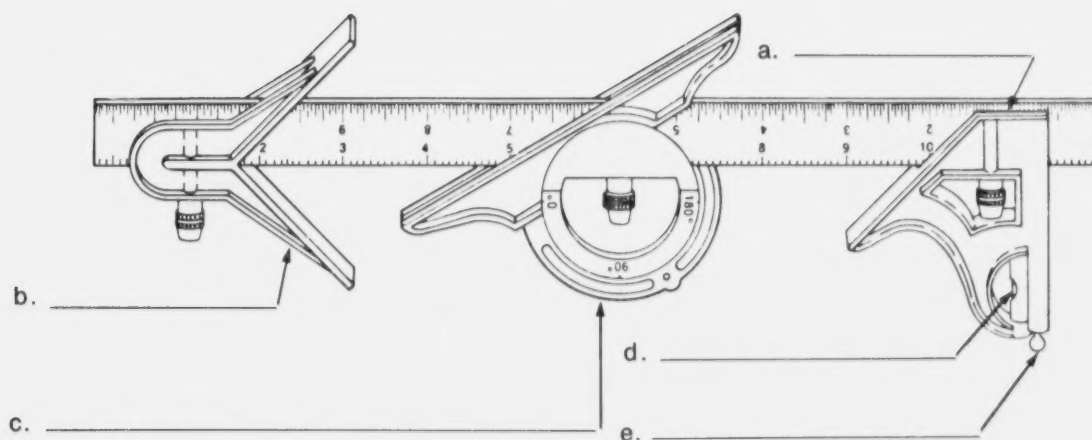
Problems used with permission of Aviation Maintenance Publishers, Riverton, Wyoming.

39. Select true statements related to the uses of torque wrenches. Circle the letter before each true statement.

- a. If the fastener is overtorqued, the threads are overstressed and can fail

THEORY TEST

- b. When a self-locking nut is torqued, the nut should not be run down on the threads until it contacts the washer
 - c. If a cotter hold does not line up when torquing a castellated nut, another nut should be substituted to see if the slot will line up in it
 - d. If a nut is accidentally overtorqued, it should be loosened and then retorqued to the proper value
 - e. When fasteners are lubricated, an adjustment in the table or torque values must be made
 - f. Never back off a nut or a bolt and leave it in that condition
40. Label the parts of a combination set. Write the correct answers in the blanks.

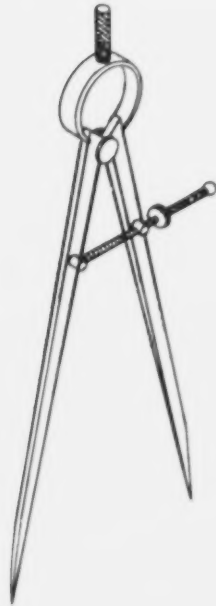


41. Use a rule.

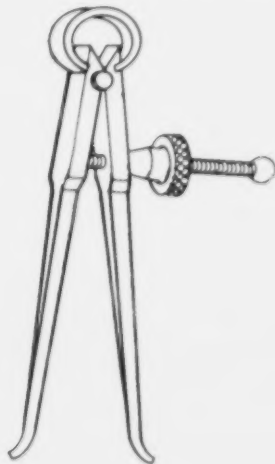
(NOTE: Test question 41 is a workbook supplement. It is an important part of this test. If it has not been completed, check with your instructor.)

THEORY TEST

42. Identify dividers and types of calipers. Write the correct names in the blanks.

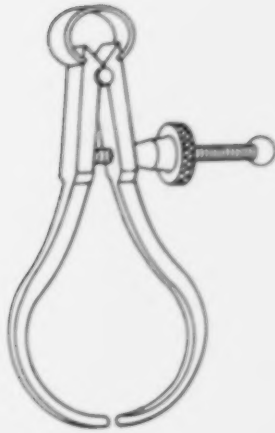


a. _____

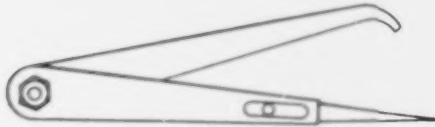


b. _____

THEORY TEST



c. _____



d. _____

THEORY TEST

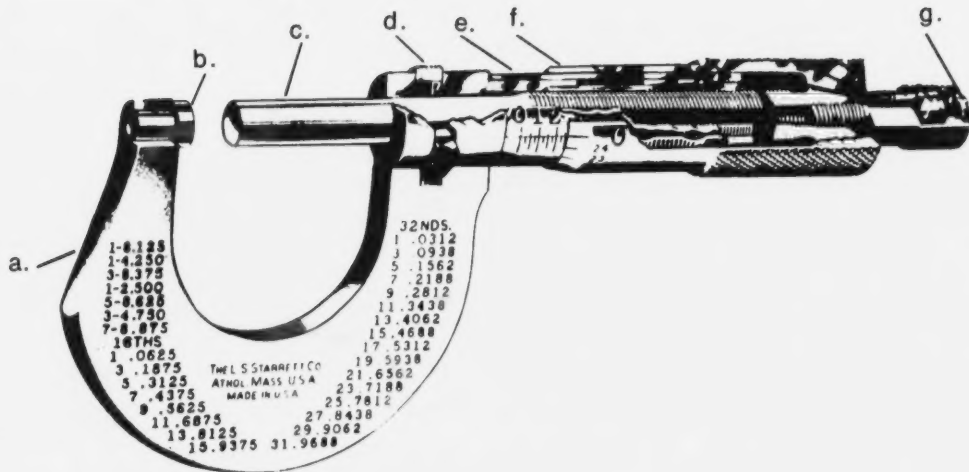
43. Match dividers and types of calipers to the correct procedures for their use. Write the correct numbers in the blanks.

- | | |
|--|--|
| <p>_____ a. First cover the metal with a layout dye and mark the base line in the dye with a very sharp scriber. Then make a very light prick punch mark on the base line from which all measurements will be made. Set the instrument with a steel scale to the distance desired, and then, with one point in the prick punch mark, scratch through the transfer dye on the base line with the other leg</p> <p>_____ b. To measure the diameter of a hole, adjust the instrument until it fits exactly across the widest part of the hole being measured, and then the distance between the points is measured with a steel scale</p> <p>_____ c. The legs of the instrument are adjusted until they fit exactly across the dimension to be measured and then they are taken from the material and the distance between the points is measured with a steel scale</p> <p>_____ d. Used to scribe a mark along a piece of material that is a specific distance from the edge. The material is covered with layout dye, and the distance between the two points is adjusted to the distance the line should be from the edge of the part. The caliper point is moved along the edge as the sharp point is drawn across the surface</p> | <p>1. Hermaphrodite calipers</p> <p>2. Dividers</p> <p>3. Outside calipers</p> <p>4. Inside calipers</p> |
|--|--|

44. State the purpose of the micrometer caliper.

THEORY TEST

45. Label the parts of a micrometer caliper. Write the correct answers in the blanks.



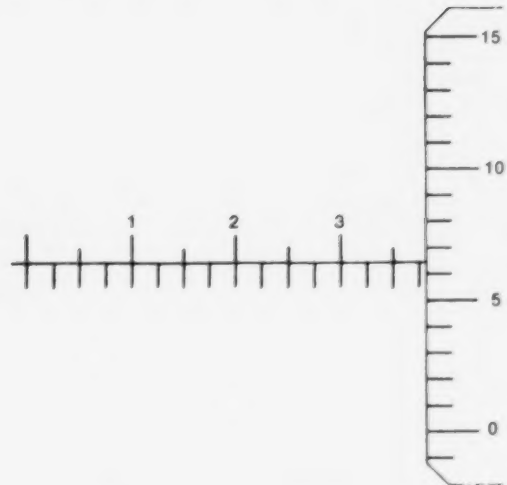
- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____

THEORY TEST

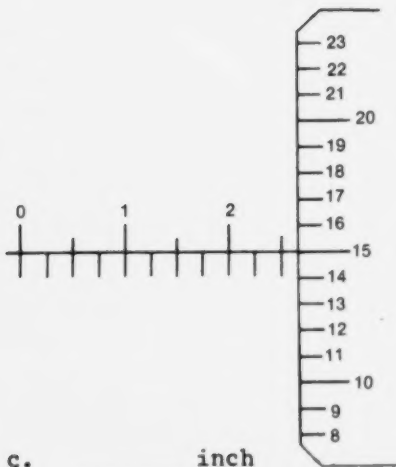
46. Interpret the following drawings of micrometer readings. Write the correct readings in the blanks.



a. _____ inch



b. _____ inch



c. _____ inch

THEORY TEST

47. State the purpose of vernier micrometer calipers.

48. Explain the process for using an inside micrometer.

49. Explain the process for using a micrometer depth gage.

50. Explain the process for using vernier calipers.

(NOTE: Test questions 51-54 are project guides. They are an important part of this test. If they have not been completed, check with your instructor.)

THEORY TEST

51. Use the micrometer caliper.

52. Use the inside micrometer.

53. Use the depth micrometer.

54. Use vernier caliper to take inside, outside, and depth measurements.

55. List uses of a drill press.

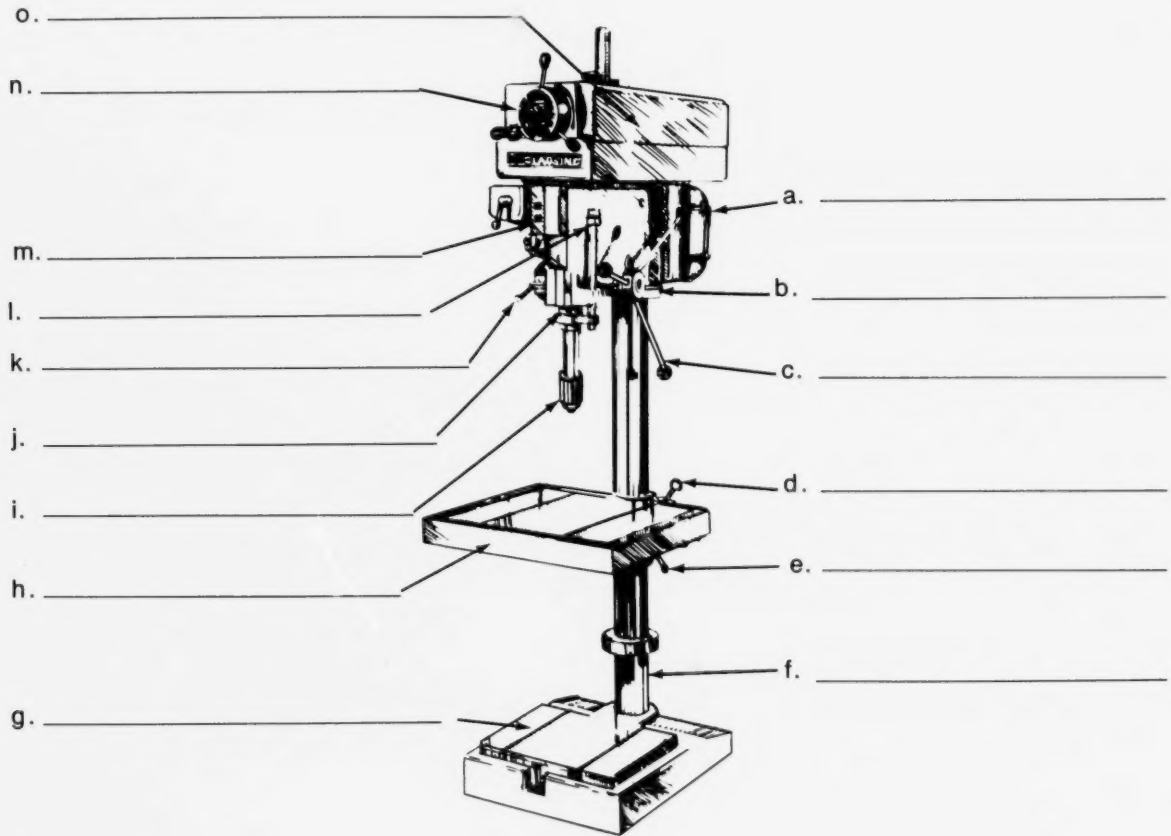
- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

56. State ten rules for safe use of drill presses. Write the correct answers in the blanks.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____
- h. _____
- i. _____
- j. _____

THEORY TEST

57. Label the parts of a drill press. Write the correct parts in the blanks.



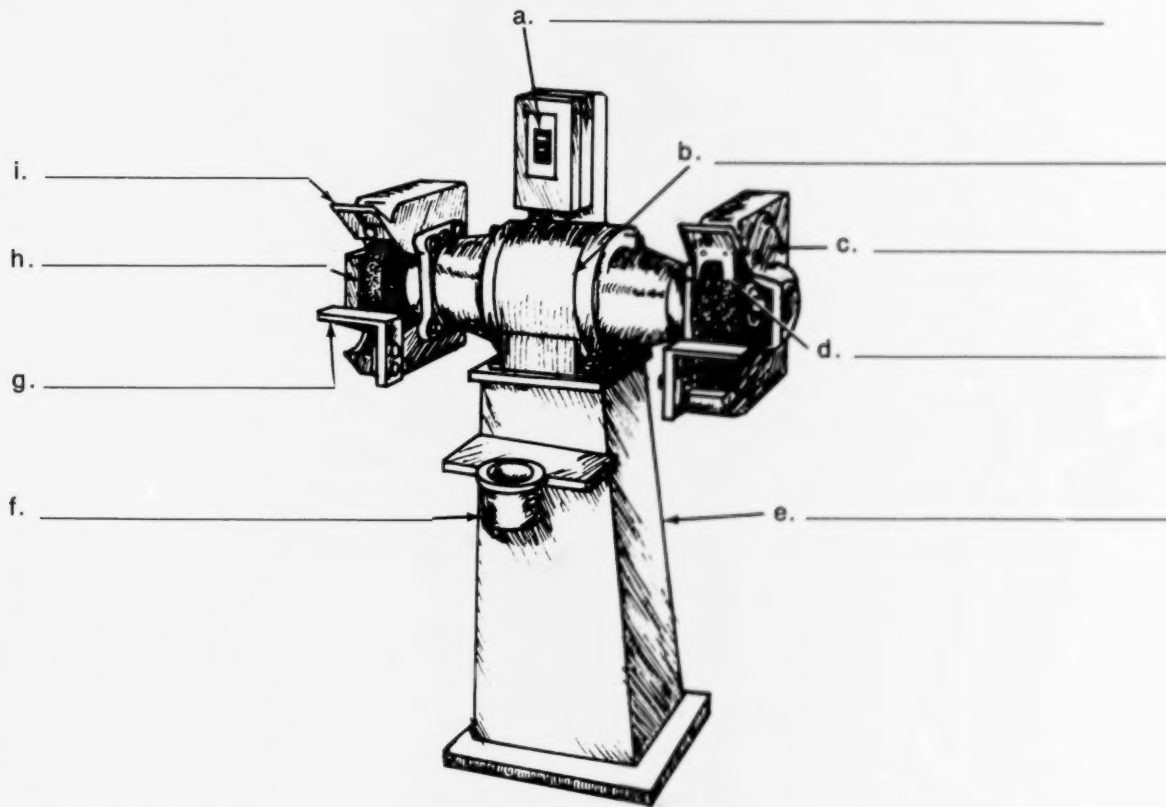
58. State ten rules for safe use of bench grinders. Write the correct answers in the blanks.

- _____
- _____
- _____
- _____
- _____
- _____
- _____

THEORY TEST

- h. _____
- i. _____
- j. _____

59. Label the parts of a bench grinder. Write the correct part names in the blanks.



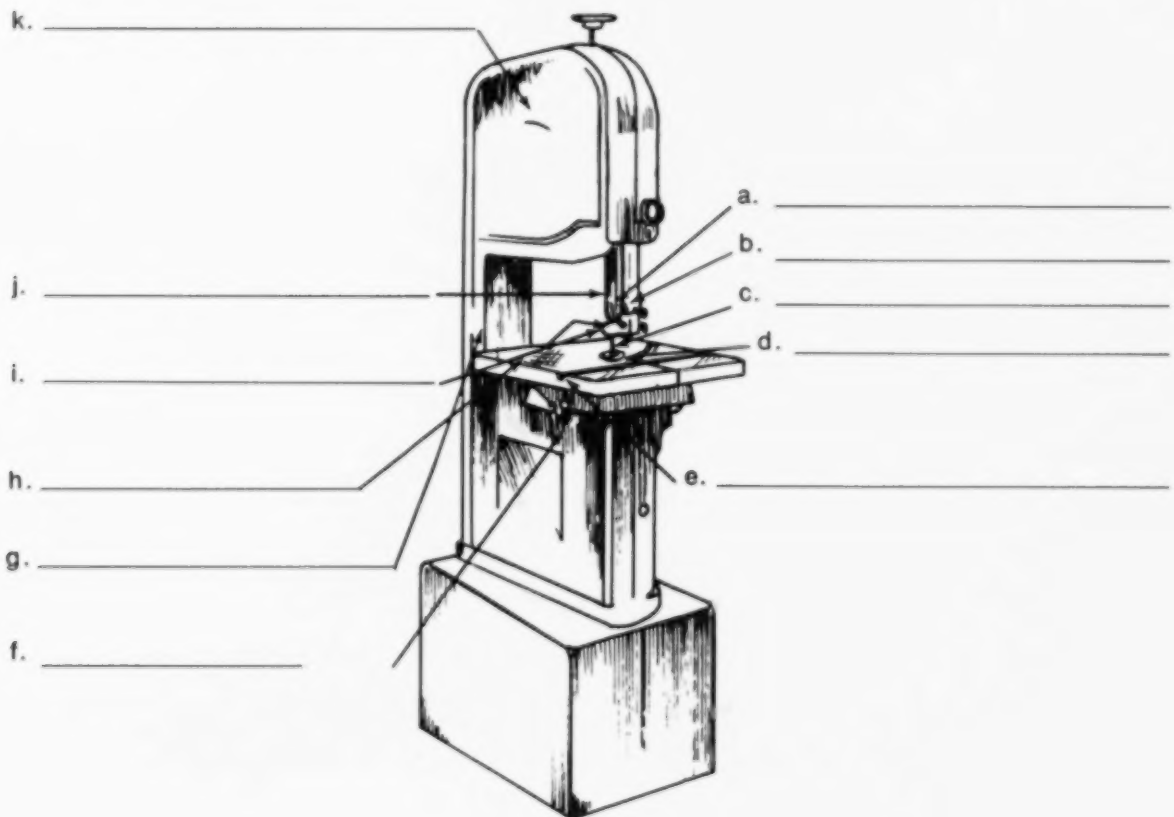
60. State ten rules for safe use of band saws. Write the correct answers in the blanks.

- a. _____
- b. _____
- c. _____

THEORY TEST

- d. _____
- e. _____
- f. _____
- g. _____
- h. _____
- i. _____
- j. _____

61. Label the parts of a band saw. Write the correct part names in the blanks.



THEORY TEST

62. State the rules for safe use of pneumatic portable power drills. Write the correct answers in the blanks.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____

63. Use hand and power tools.

(NOTE: Test question 63 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

GENERAL
G104 TECHNICAL MECHANICS
USE HAND AND POWER TOOLS AND PRECISION MEASURING INSTRUMENTS
G104-B

ANSWERS TO THEORY TEST

1. Answer should include any seven of the following
 - a. Use correct tool for the job
 - b. Keep tools sharp
 - c. Keep tools clean
 - d. Inspect tools frequently to make sure they are in good condition
 - e. Repair broken or damaged tools promptly
 - f. Dispose of broken or damaged tools that cannot be repaired
 - g. Store tools properly when not in use
 - h. Stay alert when using tools
 - i. Wear eye protection when necessary
2.

a. Ball peen hammer b. Cross peen hammer c. Straight peen hammer d. Claw hammer	e. Sledgehammer f. Body hammer g. Mallet
---	--
3.
 - a. 3
 - b. 5, 7
 - c. 4
 - d. 6
 - e. 2
 - f. 1
4.
 - a. Prick punch
 - b. Pin punch
 - c. Starting punch
 - d. Center punch
 - e. Transfer punch

ANSWERS TO TEST

5. a. 3
b. 1
c. 2
d. 5
e. 4
6. a. Slip-joint pliers
b. Interlocking-joint pliers
c. Vise-grip pliers
d. Duckbill pliers
e. Needle-nose pliers
f. Diagonal cutters
g. Safety wire cutters/twisters
7. a. 5 e. 7
b. 1 f. 6
c. 2 g. 4
d. 3
8. a. Flat or cold chisel
b. Single-bevel cape chisel
c. Diamond-point chisel
d. Double-bevel cape chisel
9. a. 3
b. 1
c. 2
10. a. Hand file
b. Half-round file
c. Vixen file
d. Round file
e. Knife file
f. Mill file
g. Three-square/triangular file
h. Wood rasp
11. a. 5
b. 1
c. 4
d. 6
e. 2
f. 3

ANSWERS TO THEORY TEST

12. a. Tang
b. Length
c. Heel
d. Face
e. Edge
f. Point
13. a, b, d, f
14. a. Straight-cut aviation snips
b. Right-cut aviation snips
c. Tinner's or tin snips
d. Left-cut aviation snips
15. a. Cross-cut saw
b. Ripsaw
c. Backsaw
d. Keyhole saw
e. Hacksaw
16. a. 2
b. 4
c. 5
d. 3
e. 1
17. a, c
18. a. Wood auger bit
b. Flat wood-boring bit
19. a. Body
b. Shank
c. Land
d. Flute
20. a, c, d, g

ANSWERS TO TEST

- 21. a. Fly cutter
b. Reamer
c. Hole saw
d. Countersink

- 22. a. Bottoming reamer with straight flutes
b. Expansion reamer with straight flutes
c. Tapered reamer with spiral flutes
d. Tapered reamer with straight flutes

- 23. Used to cut threads on the inside of a hole

- 24. a. 1
b. 5
c. 3
d. 2
e. 4

- 25. Evaluated to the satisfaction of the instructor

- 26. a. Taper tap
b. Bottoming tap
c. Plug tap

- 27. Evaluated to the satisfaction of the instructor

- 28. Used to cut thread on the outside of a rod or a pipe

- 29. a. Thread-chasing or restoring die
b. Round split die

- 30. a. Slotted screwdriver
b. Offset slot screwdriver
c. Yankee spiral-type screwdriver
d. Phillips screwdriver
e. Reed and Prince screwdriver
f. Phillips Tri-wing screwdriver
g. Phillips Posidriv screwdriver

ANSWERS TO THEORY TEST

31. a. Box-end wrench
b. Open-end wrench
c. Combination wrench
d. Flare-nut wrench
e. Ratcheting open-end wrench
f. Ratcheting box-end wrench
32. a. Deep socket
b. Crowfoot wrench socket
c. Flex socket
33. Put the proper bit or socket on the driver and place it on the fastener; then, strike the driver with a sharp hammer blow
34. It does not apply a smooth and even torque to a fastener, but it applies its force in a series of jerks or impacts; because of this it will actually apply a much higher peak torque than that for which the wrench is set
35. a. Deflecting-beam torque wrench
b. Micrometer setting torque wrench
c. Torsion-bar-type torque wrench
36. a. Inch-pounds
b. Foot-pounds
c. Meter- or centimeter-kilograms
37. $T = \frac{T(L+A)}{L}$
38. a. 250 inch-pounds
b. 396 inch-pounds
c. 280 inch-pounds
39. a, c, d, f
40. a. Stock head
b. Center head
c. Protractor head
d. Level
e. Scriber
41. Evaluated to the satisfaction of the instructor

ANSWERS TO THEORY TEST

42. a. Dividers
b. Inside calipers
c. Outside calipers
d. Hermaphrodite calipers
43. a. 2
b. 4
c. 3
d. 1
44. Used to measure the thickness of sheet metal and to measure the fits of almost all engine parts
45. a. Frame
b. Anvil
c. Spindle
d. Lock nut
e. Sleeve
f. Thimble
g. Ratchet screw
46. a. 0.238 inch
b. 0.3815 inch
c. 0.265 inch
47. To take measurements in increments smaller than one-thousandth of an inch
48. Insert the caliper into the opening to be measured. Adjust the caliper until it is exactly the same size as the opening to be measured and then remove the caliper from the opening
49. Place the bar across the groove to be measured; screw down the spindle until it contacts the bottom of the groove being measured
50. Loosen the lock screws on both the movable jaw and the clamp of the calipers and move the jaw to the approximately correct position and lock the clamp of the caliper into place. Use the adjustment screw on the clamp, move the jaw into its correct position, and lock it. Read the distance between the jaws on the vernier scale

ANSWERS TO THEORY TEST

51. Performance skills evaluated to the satisfaction of the instructor
52. Performance skills evaluated to the satisfaction of the instructor
53. Performance skills evaluated to the satisfaction of the instructor
54. Performance skills evaluated to the satisfaction of the instructor
55. a. Drilling
b. Countersinking
c. Reaming
d. Honing
e. Counterboring
56. Answer should include any 10 of the following
- a. Obtain permission from the instructor to operate the machine
 - b. Wear proper clothing and eye protection
 - c. Make sure all guards are in place and are operating properly
 - d. Hold material securely with vise or clamps
 - e. Be sure key is removed from chuck
 - f. Select a properly sharpened bit
 - g. Turn off power if drill is caught in the workpiece
 - h. Adjust table or depth stop to avoid drilling into table
 - i. Select the correct speed for material being drilled
 - j. Withdraw bit frequently when drilling large or deep holes to prevent damage to bit
 - k. Use cutting oil when drilling metals to cool drill bit
57. a. Motor
b. Head support safety collar
c. Pilot wheel feed
d. Table locking clamp
e. Tilt-angle locking clamp
f. Column
g. Lower table or base
h. Tilting table
i. Key chuck
j. Quill
k. Quill lock
l. Depth stop
m. Switch
n. Variable-speed pilot wheel
o. Belt guard

60. Answer should include any 10 of the following

- | | |
|-------------------------------|-------------------------|
| a. Switch | f. Water pot |
| b. Motor | g. Adjustable tool rest |
| c. Wheel guard | h. Grinding wheel |
| d. Adjustable spark deflector | i. Safety shield |
| e. Pedestal | |

- G104B-212 **318**

ANSWERS TO THEORY TEST

61. a. Blade support
b. Guide post
c. Blade
d. Table insert
e. Miter gauge groove
f. Table clamp
g. Rear blade guard
h. Table
i. Blade guides
j. Blade guard
k. Upper wheel guard
62. Answer should include any 10 of the following
- a. Make sure all air fittings are securely connected to drill
 - b. Always use well-sharpened bits
 - c. Make sure that the drill is properly oiled and maintained
 - d. Always know what is behind the material being drilled
 - e. Use only enough pressure to cause one long, spiral chip to form
 - f. Avoid wearing loose clothing, and tie back long hair
 - g. Do not key chuck while air line is coupled
63. Performance skills evaluated to the satisfaction of the instructor

MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G104 TECHNICAL MECHANICS
IDENTIFY AND SELECT AIRCRAFT HARDWARE
G104-C

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MODULE CONTENTS

- A. Introduction and Module Objectives
- B. Specific Objectives
- C. Instructor's Module Implementation Guide - Instructional Supplement #1 - Instructions for Aircraft Hardware Board
- D. Technical Information Supplements
 - 1. Technical Information Supplement #1 - Terms and Definitions
 - 2. Technical Information Supplement #2 - Bolt Tables
- E. Transparency Masters
 - 1. TM #1 - Standards Used for Aircraft Materials
 - 2. TM #2 - Rivet Head and Length Designations
 - 3. TM #3 - Aircraft Rivet Identification
 - 4. TM #4 - Removing a Mechanically Locked Blind Rivet
 - 5. TM #5 - Determining the Length of Blind Rivets
 - 6. TM #6 - Bulbed Cherrylock Rivet Steps
 - 7. TM #7 - Installation of Hi-Shear Rivets
 - 8. TM #8 - Removing Hi-Shear Rivets
 - 9. TM #9 - Goodrich Rivnuts and Installation Tools
 - 10. TM #10 - AN21 Through AN36 Clevis Bolts
 - 11. TM #11 - High-Strength Internal Wrenching Bolts MS20004 Through MS200024
 - 12. TM #12 - Drilled-Head Engine Bolts AN73 Through AN81
 - 13. TM #13 - Material Identification by Bolt Head Markings
 - 14. TM #14 - Standard Aircraft Nuts

MODULE CONTENTS

15. TM #15 - Self-Locking Nuts
 16. TM #16 - Tinnerman Nuts
 17. TM #17 - Aircraft Washers
 18. TM #18 - Fillister-Head Machine Screws
 19. TM #19 - Measurement Nomenclature of Structural Screws
 20. TM #20 - Machine Screws
 21. TM #21 - Self-Tapping Sheet Metal Screws
 22. TM #22 - Pins
 23. TM #23 - Hole Repair Hardware
 24. TM #24 - Parts of the Dzus Fastener
 25. TM #25 - Parts of a Camlock Fastener
 26. TM #26 - Parts of an Airlock Fastener
 27. TM #27 - Construction of Aircraft Cable
 28. TM #28 - Cable Terminals
 29. TM #29 - Swaged Cable Terminals
 30. TM #30 - Turnbuckle Nomenclature
 31. TM #31 - Examples of Safetying
 32. TM #32 - Safetying a Cotter Pin Installation
 33. TM #33 - Safetying Turnbuckles
 34. TM #34 - Safetying Turnbuckles (Continued)
- F. Project Guides
1. Project Guide #1 - Fabricate a Nicopress Oval Sleeve Cable Terminal
 2. Project Guide #2 - Identify, Select, and Install Aircraft Hardware
 3. Project Guide #3 - Safety Aircraft Hardware
- G. Theory Test
- H. Answers to Theory Test

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INTRODUCTION

Aircraft hardware is the term used to describe the many assorted fasteners, nuts, washers, locking devices, and the multitude of miscellaneous small items used in the manufacture and repair of aircraft. Many of these items are small and their significance is often misunderstood. Hardware is to an aircraft as the atom is to matter. Although an atom is small and invisible, it is the foundation upon which all matter is constructed. The many individual small items of hardware play exactly the same role in an aircraft structure. They are the element which binds the structure together. Without the correct hardware installed in the proper manner, the aircraft structure is weak and unsafe.

MODULE OBJECTIVE

After completion of this module, you will be able to select and identify aircraft hardware, fabricate a Nicopress oval sleeve cable terminal, and safety aircraft hardware. You will demonstrate this knowledge by completing the procedures outlined in the workbook assignments and project guides. You will further demonstrate this knowledge by scoring a minimum of 85 percent on the module theory test.

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SPECIFIC OBJECTIVES

After completion of this module, you will be able to:

- | | |
|--|--|
| 1. Match terms related to aircraft hardware to their correct definitions. (1) | Technical Supplement #1 |
| 2. Identify aircraft rivets by alloy, specification code, symbol, and head marking. (2) | EA-ITP-G 5:I:2-3
EA-ITP-GW 5:I:1 |
| 3. State facts related to general use of aircraft rivets. (1) | EA-ITP-G 5:I:2-4
AC 65-9A 150-154 |
| 4. Match general use aircraft rivet head designs to their correct AN specification numbers. (1) | EA-ITP-G 5:I:3
EA-ITP-GW 5:I:2 |
| 5. Select true statements related to special rivets. (1) | EA-ITP-G 5:I:4-12 |
| 6. State facts related to standard aircraft bolt types, thread fits, specification numbers, applications, and installations. (1) | EA-ITP-G 5:I:12-17
AC 65-9A 132-135
AC 43.13-1A 115-118 |
| 7. Identify common aircraft bolts by head markings and head shapes. (2) | EA-ITP-G 5:I:12-17
EA-ITP-GW 5:I:3-6
Technical Supplement #2 |
| 8. Identify the main types of nuts used in aircraft construction. (2) | EA-ITP-G 5:I:17-22 |
| 9. Select facts related to nuts used in aircraft construction. (1) | EA-ITP-G 5:I:25-26
AC 43.13-1A 119-120
EA-ITP-GW 5:I:6-8 |
| 10. Identify the common types of washers used in aircraft construction. (1) | EA-ITP-G 5:I:26-28
EA-ITP-GW 5:I:8-9 |
| 11. Identify washers by specification numbers and state their uses. (2) | EA-ITP-G 5:I:26-28 |
| 12. List types of screws used in aircraft construction. (1) | EA-ITP-G 5:I:22-25
EA-ITP-GW 5:I:8 |

SPECIFIC OBJECTIVES

- | | | |
|--|-----------------------|----------------------|
| 13. Identify types of pins commonly used in aircraft construction. (2) | EA-ITP-G
EA-ITP-GW | 5:I:25-26
5:I:9 |
| 14. State facts related to both screws and pins used in aircraft construction. (1) | EA-ITP-G | 5:I:22-26 |
| 15. List the two uses of inserts for repairing threaded and unthreaded holes. (1) | EA-ITP-G | 5:I:28-29 |
| 16. Identify Dzus, airlock, and Camlock fasteners. (2) | EA-ITP-G | 5:I:29-30 |
| 17. State facts related to Dzus, airlock and Camlock fasteners. (1) | EA-ITP-G | 5:I:29-30 |
| 18. State facts related to aircraft cable and cable terminals. (1) | EA-ITP-G
EA-ITP-GW | 5:I:30-34
5:I:9 |
| 19. Fabricate a Nicopress oval sleeve cable terminal. (3) | Project Guide #1 | |
| 20. State facts related to aircraft turn-buckles. (1) | EA-ITP-G
EA-ITP-GW | 5:I:34
5:I:10 |
| 21. State facts related to safetying methods used in aircraft construction. (1) | EA-ITP-G
AC 65-9A | 5:I:34-36
145-150 |
| 22. Identify, select, and install aircraft hardware. (3) | Project Guide #2 | |
| 23. Safety aircraft hardware. (3) | Project Guide #3 | |

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INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module

A. Videotapes

1. Identification and Application of Aircraft Hardware, ITP-G5, Program 1.
2. Rivet Identification, ITP-S-113.

(NOTE: These materials are available from Aviation Maintenance Publishers, Inc., P.O. Box 36, 1000 College View Drive, Riverton, Wyoming 82501.)

B. Book: Standard Aircraft Handbook, Leavell and Bungay, 1977.

(NOTE: This book is available from Aero Publishers, Inc., 329 West Aviation Road, Fallbrook, California 92028.)

II. Implementation Suggestions

(NOTE: Have students read all material related to the Specific Objectives.)

Estimated Teaching Time		Theory	Lab
Objective 1	Explain the terms and definitions related to aircraft hardware as they are encountered in the text. Have students refer to Technical Supplement #1		
Objective 2	Explain how to identify general use aircraft rivets by alloy, specification code, symbol, and head markings. Use Transparency Masters #1-#2. Have students complete EA-ITP-GW 5:I:1.		
Objective 3	Discuss general use of aircraft rivets. Discussion should include the various alloys and their applications, the different forces rivets are subjected to, and their importance to the aircraft structure.		

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objective 4	Explain the relationship of AN specification numbers and head markings for aircraft rivets. Use Transparency Master #3. Have students complete EA-ITP-GW 5:I:1-2.	
Objective 5	Discuss special rivet types, applications, installation methods, and removal methods. Use Transparency Masters #4-#9. Show videotape <u>Rivet Identification</u> , ITP-S-113.	
Objective 6	Explain aircraft bolts. Include types, thread fits, specification numbers, applications, and installations in this discussion. Have students refer to Technical Supplement #2. Be sure to discuss the use of the AN Bolt Gauge and the grip length gauge. Show students an AN Bolt Gauge. Use Transparency Masters #10-#12.	
Objective 7	Identify for the class aircraft bolts by head markings and head shapes. Use Transparency Master #13. Have students complete EA-ITP-GW 5:I:3-6.	
Objective 8	Identify types of nuts used in aircraft construction. Show the students examples of each type of nut. Use Transparency Masters #14-#16.	
Objective 9	Explain aircraft nuts. Include the types, specification numbers, materials, and applications. Show the students examples of as many types of nuts as possible. Have students complete EA-ITP-GW 5:I:6-8.	
Objective 10	Show the class the various types of washers. Use Transparency Master #17. Have students complete EA-ITP-GW 5:I:8-9.	
Objective 11	Explain how washers are identified by specification number and explain the use of each type of washer.	

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 12	Explain the three types of screws. Show examples of each. Use Transparency Masters #18-#21. Have students complete EA-ITP-GW 5:I:8.		
Objective 13	Explain how to identify the four types of pins used in aircraft construction. Show examples of each during the explanation. Use Transparency Master #22. Have students complete EA-ITP-GW 5:I:9.		
Objective 14	Discuss the materials, usages, installation, and removal methods of screws and pins used in aircraft construction. Show examples of as many types of screws and pins as possible.		
Objective 15	Discuss the inserts used for repairing threaded and unthreaded holes. Include the purpose, materials, applications, and installation methods. Use Transparency Master #23. Demonstrate the installation of an Helicoil insert.		
Objective 16	Explain how to identify Dzus, airlock, and Camlock fasteners. Show examples of each. Use Transparency Masters #24-#26.		
Objective 17	Discuss the materials, usages, and nomenclature related to Dzus, airlock, and Camlock fasteners. Point out how to tell when a Dzus fastener is damaged.		
Objective 18	Discuss aircraft cable and cable terminals. Include the types, materials, applications, construction, and strengths. Use Transparency Masters #27-#29. Have students complete EA-ITP-GW 5:I:9.		
Objective 19	Discuss the procedures for Project Guide #1. Demonstrate how to properly fabricate a Nicropress oval sleeve terminal. Have students complete Project Guide #1.		

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objective 20	Discuss aircraft turnbuckles. Include in the discussion the sizes, applications, installation methods, specification numbers of each type, and inspection methods. Use Transparency Master #30. Show ITP-G5, Program 1, Identification and Application of Aircraft Hardware. Have students complete EA-ITP-GW 5:I:10.	
Objective 21	Explain safetying practices used in aircraft construction. Use Transparency Masters #31-#34.	
Objective 22	Discuss Project Guide #2. Explain the procedures outlined in the project guide. Answer any student questions before beginning the project. Have students complete Project Guide #2. Instructions for the construction of the hardware board are in Instructional Supplement #1.	
Objective 23	Discuss Project Guide #3. Demonstrate how to safety various types of hardware on the hardware board. Have students complete Project Guide #3.	

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INSTRUCTIONAL SUPPLEMENT #1 - Instructions for Aircraft Hardware Board

- A. Purchase enough 1/4-inch plate (aluminum) to fabricate hardware boards, Blocks AA and BB. Sketch 1 is an actual size drawing of the board required to accomplish Project Guide #2. Sketch 2 is an auxiliary sketch which will show the order of attachment for blocks AA and BB. Sketch 1 and 2 can be used to construct and assemble Flange X and Plate F1.
- B. Purchase enough 0.040-inch aluminum to construct flange X and Plate F1.
- C. Cut 1/4-inch aluminum plate to size. Cut the 0.040-inch aluminum to size and bend flange X.
- D. Overlay a copy of the hardware board sketch on the plate.
- E. Drill the following holes.

Block A - Hole

1. - 10. 1/4 inch

Block B - Hole

1. 1/4 inch
2. 1/4 inch
3. 1/4 inch

Block C - Hole

1. 1/4 inch
2. 1/4 inch
3. #10 drill size
4. #10 drill size
5. - 6. 1/8 inch

Block D - Hole

1. 5/16 inch
2. 3/8 inch
3. 1/4 inch

Block E - Hole

1. - 6. #10 drill size

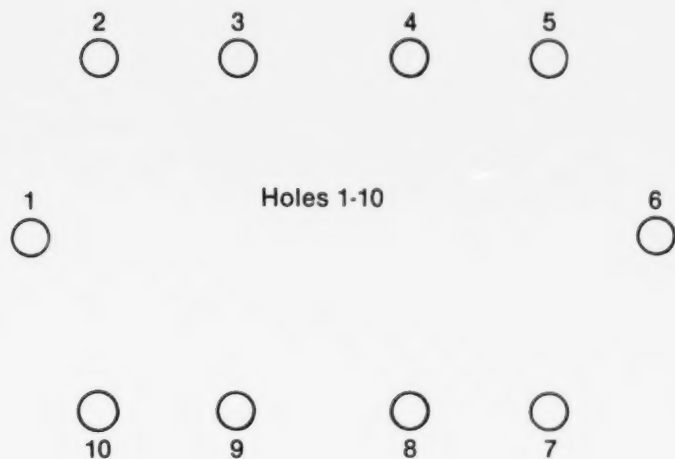
Block F - Hole

1x (both board and flange) #8 drill size
2x (both board and flange) #8 drill size
3x (both flange and plate) #35 drill size/
countersink hole 3x in flange
4x (both flange and plate) #35 drill size

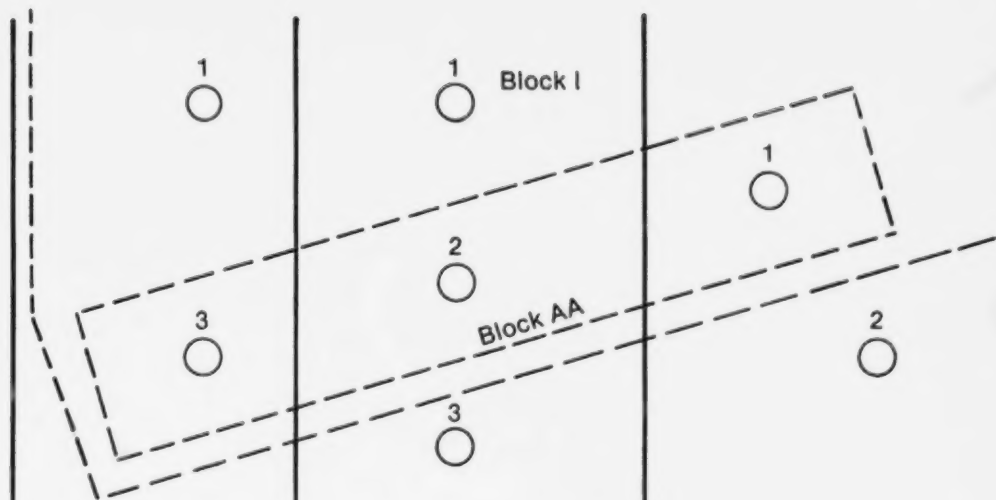
Block G - Hole

1. - 4. 5/32 drill size

G104C-13



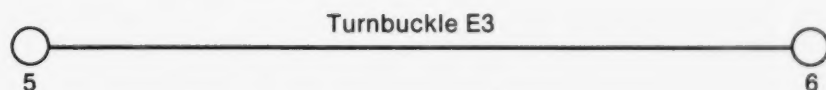
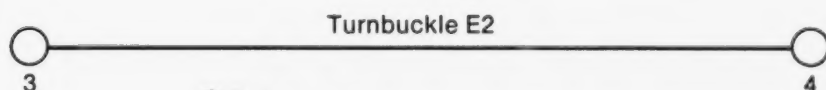
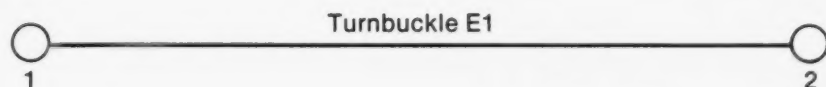
A



B

C

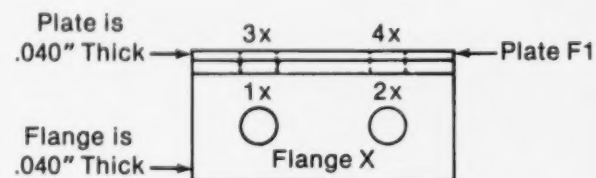
D



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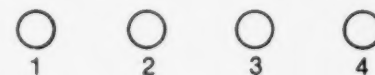
E

SKETCH #1



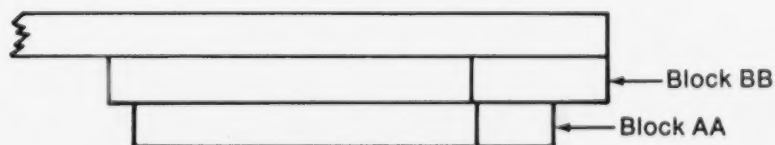
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332

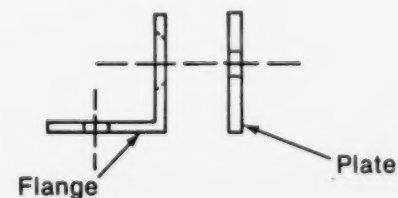


G

FRONT



View Looking From The Right



SKETCH #2

H

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TECHNICAL INFORMATION SUPPLEMENT #1 - Terms and Definitions

- A. Hardware - Nuts, bolts, screws, rivets, washers, locking devices, and other small items used to assemble aircraft parts
- B. Huck Lockbolt - Patented, threadless bolt used in the production of aircraft where high-strength, high-speed, lightweight fasteners are required
- C. Cable terminal - Connecting fitting attached to the end of a cable
- D. Rivet - Small metal pin with a specially formed head on one end, used to fasten sheet metal parts together by upsetting the shank to form a clamping head
- E. Self-locking nut - Internally threaded collar with a mechanical means to prevent loosening
- F. Thread pitch - Distance from the peak of one thread to the peak of the next thread on a screw, bolt, or other thread fitting
- G. High-strength fastener - Fastener with high tensile and shear strengths attained through combinations of materials, work-hardening, and heat treatment
- H. Washer - Flat metal disc with a central hole, used to provide a smooth surface for a nut or bolt to seat against and to shim between a nut and the surface to compensate for an improper grip length of the bolt
- I. Nut - Internally threaded collar that screws onto bolts or screws to form a complete fastening device
- J. Bolt - Externally threaded fastener
- K. High-shear rivet - Special form of threadless bolt composed of a steel pin held into the structure by an aluminum or mild-steel collar swaged into a groove around the end of the pin

(NOTE: High-shear rivets are used for high-speed, high-strength, lightweight construction of an aircraft.)
- L. Diameter - Length of a chord passing through the center of a circular body
- M. Pin - Straight cylindrical or tapered fastener, designed to perform an attaching or locating function
- N. Control cable - Specially designed steel cable connected to linkages used in flight control systems and engine controls

TECHNICAL INFORMATION SUPPLEMENT #1

- O. Internal wrenching bolt - High-strength steel bolt with a recessed head designed for tensile loads

(NOTE: Internal wrenching bolts are designed to allow the insertion of an allen type wrench.)

- P. Safetying - Installation of any type of device that prevents the loosening of an attachment
- Q. Special fastener - Fastener which differs in any respect from recognized standards
- R. Fastener - Device used to fasten two objects together

EXAMPLES: Rivet or bolt

- S. Rivnut - Hollow, blind rivet in which the inside of the shank is threaded, and the upset rivet may be used as a blind nut

(NOTE: Rivnut is patented and manufactured by the B. F. Goodrich Company.)

- T. Blind rivet - Special rivet designed to be used where it is not possible to use a bucking bar for riveting
- U. Clevis bolt - Special-purpose bolt whose round head is slotted or recessed to accept a screwdriver, having a very short threaded portion on the shank and used only for shear loads
- V. Turnbuckle - Device used in a control system to adjust cable tension, consisting of a brass barrel with both left- and right-hand threaded terminals
- W. Icebox rivets - Rivets made of 2024 or 2017 aluminum alloy, which must be heat-treated, quenched, and held in a subzero icebox until they are driven
- X. Safety wiring - Method of fastening bolt- or screw-heads together with soft wire to prevent them from becoming loose
- Y. Close-tolerance bolt - Hex-head aircraft bolt whose shank has been centerless ground to a tolerance of +0.000 -0.0005 inch
- Z. Jo-bolts - Trade name registered for a particular type of internally threaded three-piece rivet
- AA. Anchor nut - Self-locking nut which has a lug or lugs for attachment
- BB. Dzus fastener - Patented form of cowlings fastener in which a slotted stud is forced over a spring-steel wire and rotated to lock the wire in a cam-like groove

TECHNICAL INFORMATION SUPPLEMENT #1

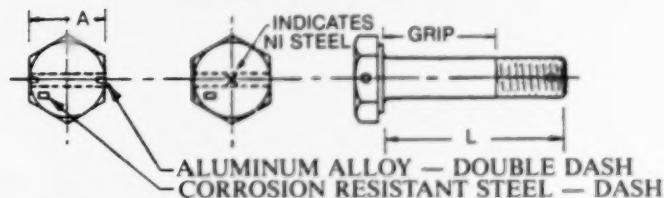
- CC. Helicoil - Registered trade name for a special helical steel insert that is screwed into specially cut threads to restore threads that have been stripped out or to provide durable threads in soft castings
- DD. Aluminum alloy - Pure aluminum to which one or more alloying elements has been added to increase its hardness, toughness, durability, and resistance to fatigue

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TECHNICAL INFORMATION SUPPLEMENT #2 - Bolt Tables

The manufacture of aircraft requires a large number of small parts including fasteners such as bolts, screws, and rivets. Many such parts have been listed and assigned a Standard Parts number by the Air Force-Navy Aeronautical Standards, abbreviated AN. The AN number has been assigned to many small parts in order to standardize, as much as possible, the use of such parts by several aircraft manufacturers. As an aviation maintenance technician, you must be able to use the many reference charts. The following charts are AN bolt tables and clevis bolt tables.

AN₁ to AN₂₀
BOLT, HEX HEAD



Material: Nickel steel (S.A.E. 2330). Process: heat-treat harden and cadmium plate.
2024-T4 Alum. Process: heat-treat harden and anodic treatment. Corrosion resistant steel.
Thread: Class $\frac{1}{2}$ NF (unless otherwise noted)

DIAMETER — BY PART NUMBER

Part No.	Dia.	A, in.	Part No.	Dia.	A, in.	Part No.	Dia.	A, in.
AN ₃ *	$\frac{3}{16}$	.375	AN ₇	$\frac{7}{16}$	.625	AN ₁₂	$\frac{3}{4}$	1.0625
AN ₄	$\frac{1}{4}$	.4375	AN ₈	$\frac{1}{2}$	.750	AN ₁₄	$\frac{7}{8}$	1.250
AN ₅	$\frac{5}{16}$	.500	AN ₉	$\frac{9}{16}$	.875	AN ₁₅	1	1.4375
AN ₆	$\frac{3}{8}$	.5825	AN ₁₀	$\frac{5}{8}$	.9375			

*SPECIAL NOTE: An AN₁ bolt is made to a No. 10-32 screw size (see p. 142) to avoid confusion since the two measurements are so nearly the same. (No. 10 screw is 190 dia., $\frac{3}{16}$ is .187.)

LENGTH — BY DASH NUMBER

Dash No.	L, in.	Dash No.	L, in.	Dash No.	L, in.	Dash No.	L, in.
-3	$\frac{3}{8}$	-7	$\frac{7}{8}$	-13	$1\frac{3}{8}$	-17	$1\frac{7}{8}$
-4	$\frac{1}{2}$	-10	1	-14	$1\frac{1}{2}$	-20	2
-5	$\frac{5}{8}$	-11	$1\frac{1}{8}$	-15	$1\frac{5}{8}$	-21	$2\frac{1}{8}$
-0	$\frac{3}{4}$	-12	$1\frac{1}{4}$	-16	$1\frac{3}{4}$	-22	$2\frac{1}{4}$

Additional lengths correspondingly coded in 8ths of an inch.

AN CODE: The material is indicated in the code by a letter preceding the dash number as follows:

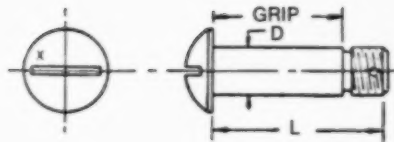
Nickel No letter
Corrosion resistant steel Letter C
Aluminum alloy.....Letters DD

The bolt may be supplied with or without the hole in either the shank or the head. This is indicated in code as follows:

UNDRILLED BOLT Add A after dash number
DRILLED SHANK ONLY.....No letter required
DRILLED HEAD ONLY.....Add H before dash number and A after dash number
DRILLED HEAD ON DRILLED SHANK Add H before dash number

Adapted with permission of Aero Publishers, Inc., c/o TAB BOOKS Inc., P.O. Box 40, Blue Ridge Summit, Pennsylvania 17214.

AN₂₁ to AN₃₆
BOLT, CLEVIS



Material: Nickel steel (S.A.E. 2330). Process: heat-treat harden and cadmium plate.
Thread: Class 3NF.

DIAMETER — BY PART NUMBER

Part No.	Size	Part No.	Dia., in.	Part No.	Dia., in.	Part No.	Dia., in.
AN ₂₁	6-40	AN ₂₄	1/4	AN ₂₇	7/16	AN ₃₀	5/8
AN ₂₂	8-36	AN ₂₅	5/16	AN ₂₈	1/2	AN ₃₂	3/4
AN ₂₃	10-32	AN ₂₆	3/8	AN ₂₉	9/16	AN ₃₄	7/8
						AN ₃₆	1

LENGTH — BY DASH NUMBER

Dash No.	L, in.	Dash No.	L, in.	Dash No.	L, in.	Dash No.	L, in.	Dash No.	L, in.
-5	5/16	-9	9/16	-13	13/16	-17	1 1/16	-21	1 5/16
-6	3/8	-10	5/8	-14	7/8	-18	1 1/8	-22	1 3/8
-7	7/16	-11	1 1/16	-15	1 5/16	-19	1 8/16	-23	1 7/16
-8	1/8	-12	3/4	-16	1	-20	1 1/4	-24	1 1/2

*Additional lengths, on larger sizes, to 7 in. are given similarly in 16ths by the dash number.

Example: AN₂₃₋₁₂ is clevis bolt size 10-32 and 3/4 in. long.

Description: AN clevis bolts are made from .001 to .002 small to allow a fit in fractional size drill holes. The short thread requires AN₃₂₀ nut or AC₃₀₄ self-locking nut. The hole in the threaded end is for a safety cotter; its absence is indicated by the letter A immediately following the dash number in the code.

Example: AN_{24-15A}.

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AN₇₃ to AN₈₁
BOLT, AIRCRAFT-DRILLED HEAD



Material: Nickel steel (S.A.E. 2330). Process: heat-treat harden and cadmium plate.

Thread: Class ₃NF or class ₃NC. (NC indicated by A inserted in code place of the usual dash.)

Size: A is the same as A for the corresponding sizes AN₃ to AN₁₆.

DIAMETER — BY PART NUMBER

Part No.	Dia., in.	Part No.	Dia., in.	Part No.	Dia., in.
AN ₇₃ *	3/16	AN ₇₆	3/8	AN ₇₉	9/16
AN ₇₄	1/4	AN ₇₇	7/16	AN ₈₀	5/8
AN ₇₅	5/16	AN ₇₈	1/2	AN ₈₁	3/4

*See special not AN₃

LENGTH — BY DASH NUMBER

Dash No.	L, in.	Dash No.	L, in.	Dash No.	L, in.	Dash No.	L, in.
-3	3/8	-7	7/8	-13	1 3/8	-17	1 7/8
-4	1/2	-10	1	-14	1 1/2	-20	2
-5	5/8	-11	1 1/8	-15	1 5/8	-21	2 1/8
-6	3/4	-12	1 1/4	-16	1 3/4	-22	2 1/4

Additional lengths correspondingly coded in 8ths of an inch.

Example: AN₇₄₋₁₀ is drilled-head bolt, 1/4 dia. and 1 in. long.

Description: The hole in the bolthead is for a safety wire. There is no hole in the threaded end for a cotter.

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Standards Used For Aircraft Materials

AMS	Aeronautical Material Specifications
AN	Air Force-Navy
AND	Air Force-Navy Design
AS	Aeronautical Standard
ASA	American Standards Association
ASTM	American Society for Testing and Materials
MS	Military Standard
NAF	Naval Aircraft Factory
NAS	National Aerospace Standard
SAE	Society of Automotive Engineers
AISI	American Iron and Steel Institute

Rivet Head and Length Designations



AN426 - MS20426
100° Countersunk Head



AN470 - MS20470
Universal Head



AN442
Flat Head



AN430
Round Head

Rivet Head Designation



Rivet Length Measurement

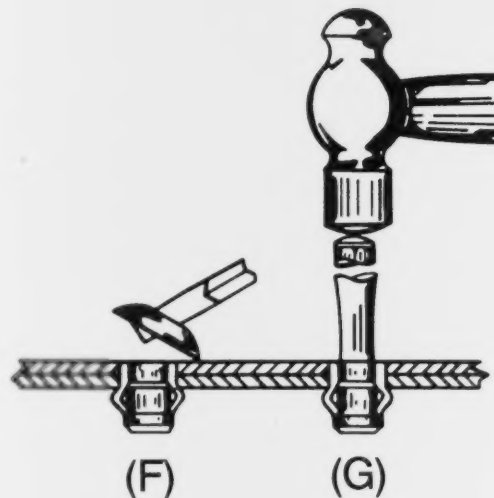
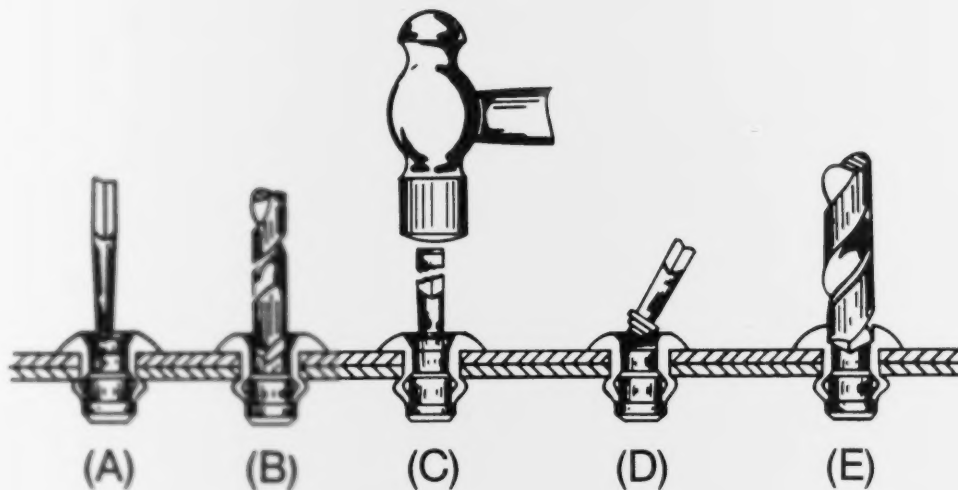
Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Aircraft Rivet Identification

RIVET MATERIAL	CODE	HEAD MARK	HEAT TREAT	SHEAR STRENGTH P.S.I.
1100 ALUMINUM ALLOY	A		NO	10,000
2117 ALUMINUM ALLOY	AD		NO	30,000
2017 ALUMINUM ALLOY	D		YES	34,000
2024 ALUMINUM ALLOY	DD	 TWO RAISED DASHES	YES	41,000
5056 ALUMINUM ALLOY	B		NO	27,000
CORROSION RESIST. STEEL	F		NO	75,000
MONEL	M		NO	55,000

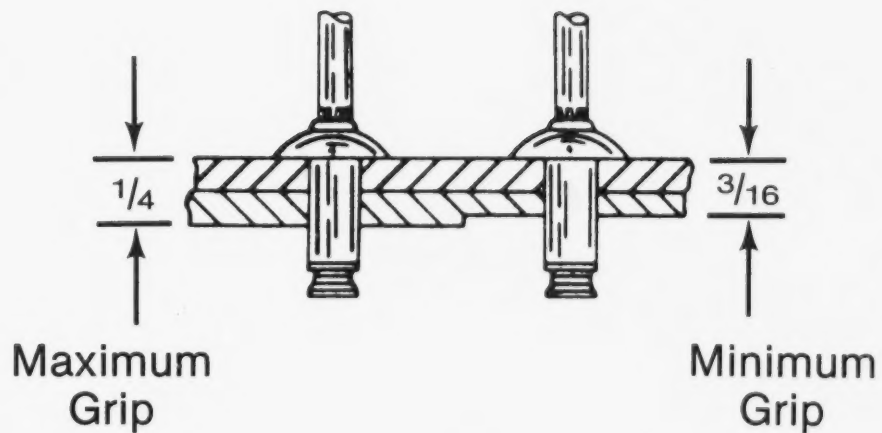
Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Removing a Mechanically Locked Blind Rivet



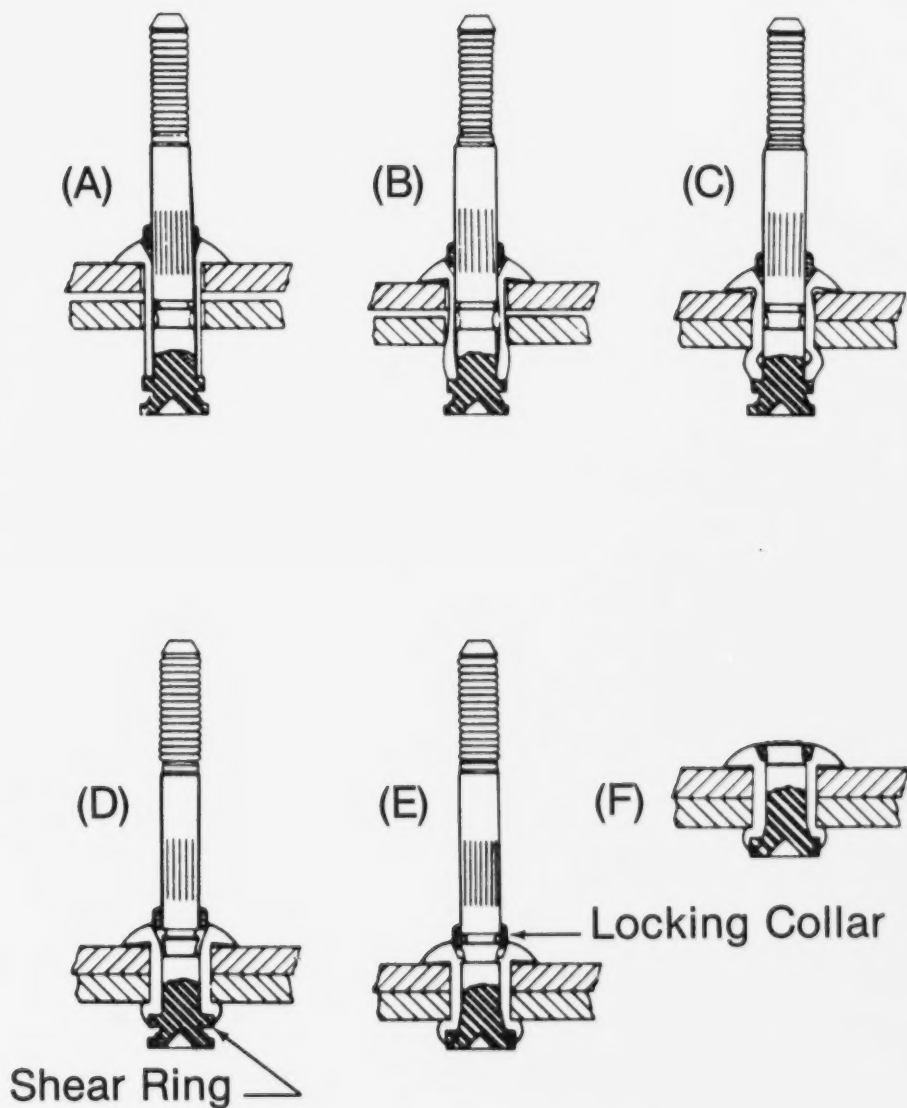
Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Determining the Length of Blind Rivets



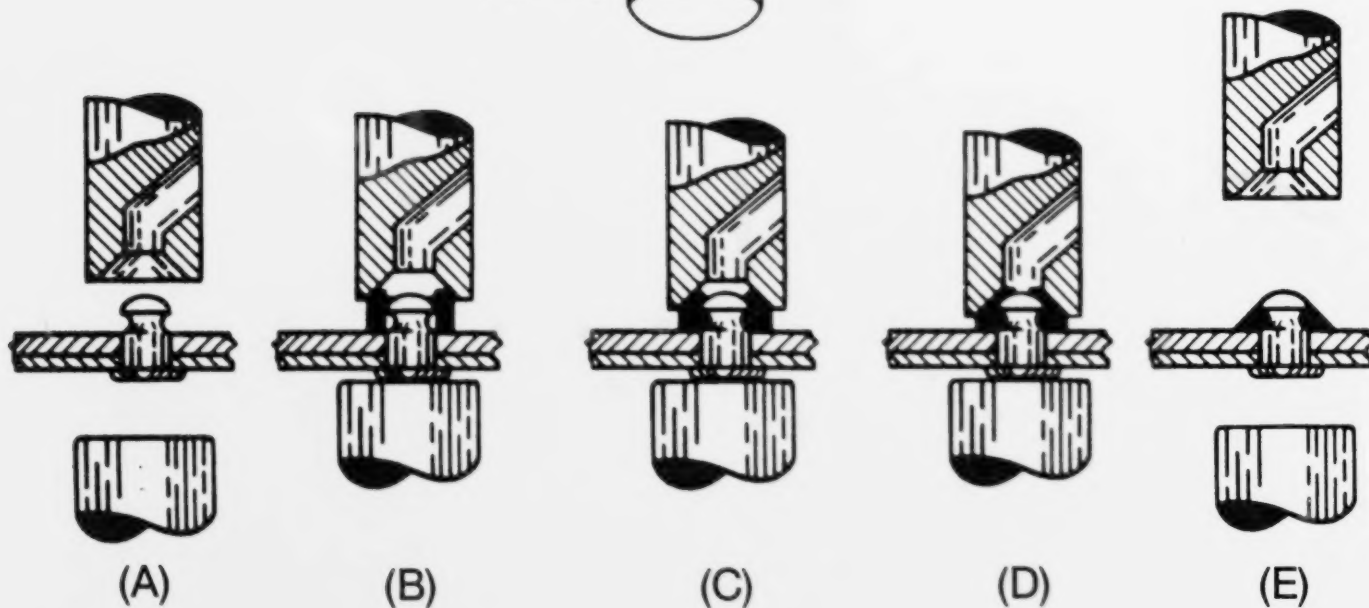
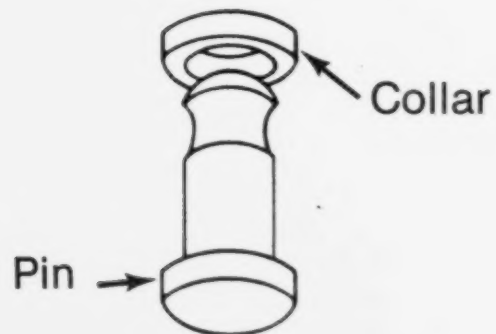
Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Bulbed Cherrylock Rivet Steps



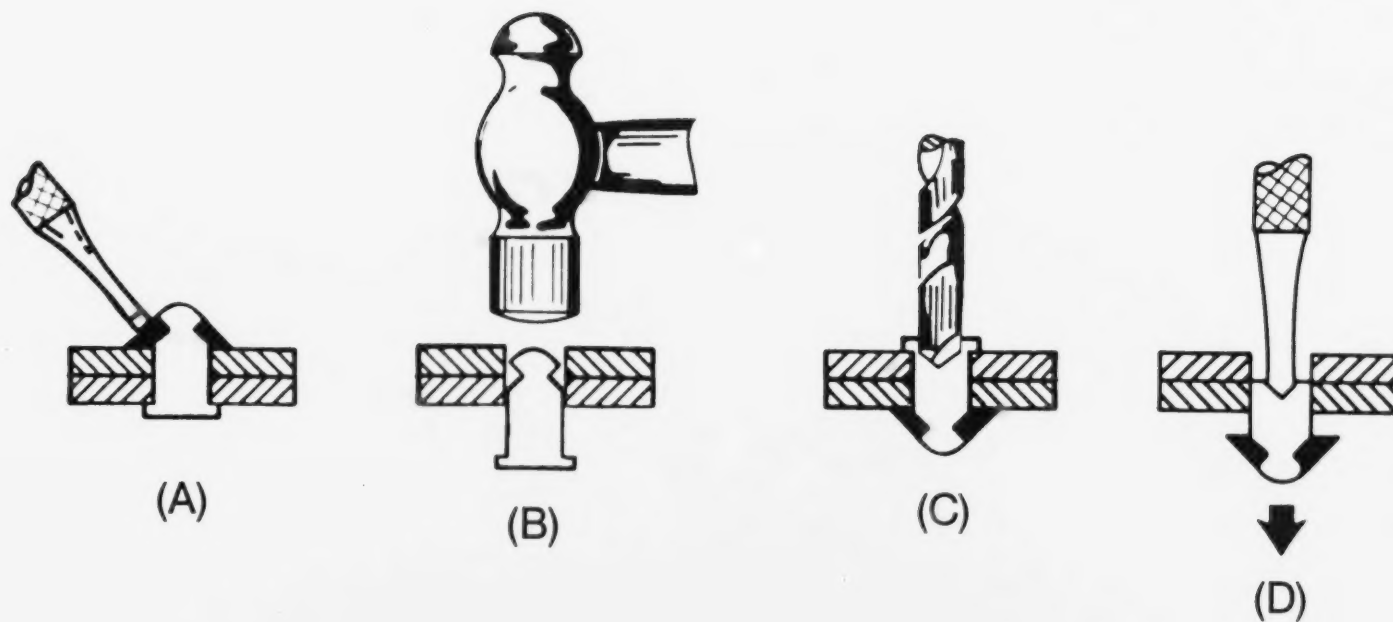
Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Installation of Hi-Shear Rivets



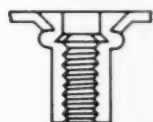
Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Removing Hi-Shear Rivets

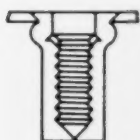


Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

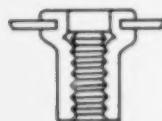
Goodrich Rivnuts and Installation Tools



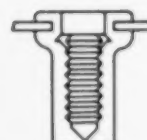
Countersunk
Rivnut with
open end



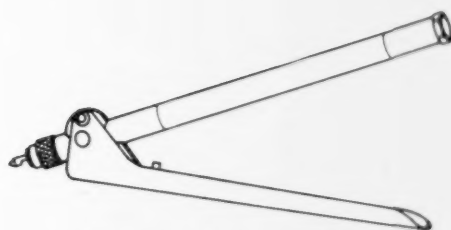
Countersunk
Rivnut with
closed end



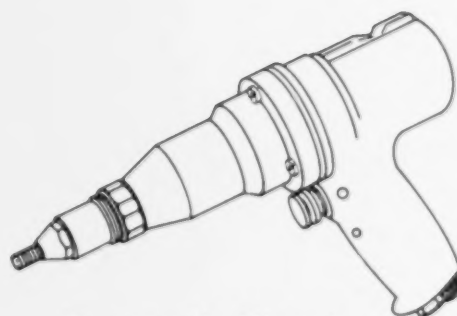
Flat-head
Rivnut with
open end



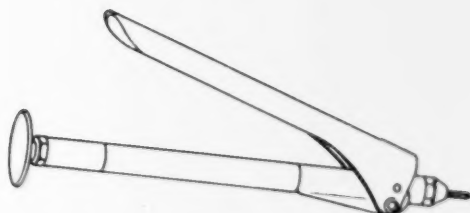
Flat-head
Rivnut with
closed end



Key Cutting Tool



Pneumatic Rivnut
Header

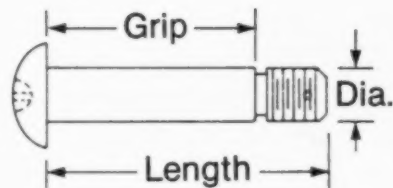


Hand Operated Rivnut Header

Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

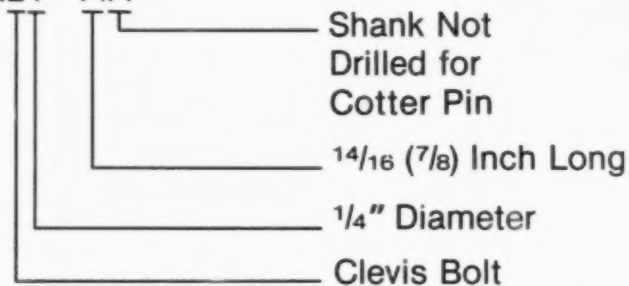
TM #9

AN21 Through AN36 Clevis Bolts



AN21	6-40 Machine Screw
AN22	8-36 Machine Screw
AN23	10-32 Machine Screw
AN24	1/4-28
AN25	5/16-24
AN26	3/8-24
AN27	7/16-20
AN28	1/2-20
AN29	9/16-18
AN30	5/8-18
AN32	3/4-16
AN34	7/8-14
AN36	1-14

AN24 - 14A

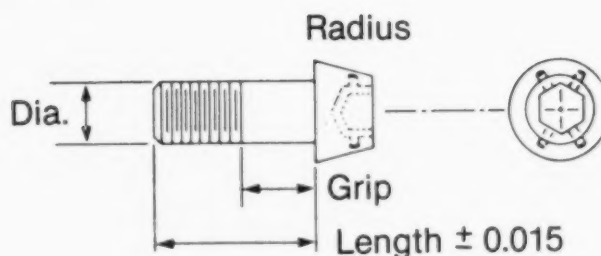


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TM #10

G104C-41

High-Strength Internal Wrenching Bolts MS20004 Through MS20024

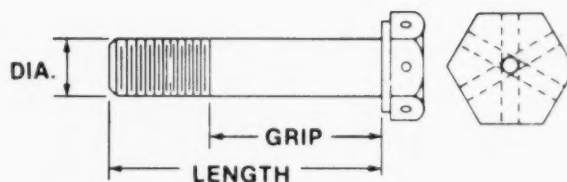


MS20004	1/4-28
MS20005	5/16-24
MS20006	3/8-24
MS20007	7/16-20
MS20008	1/2-20
MS20009	9/16-18
MS20010	5/8-18
MS20012	3/4-16
MS20014	7/8-14
MS20016	1-14
MS20018	1-1/8-12
MS20020	1-1/4-12
MS20022	1-3/8-12
MS20024	1-1/2-12

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TM #11

Drilled-Head Engine Bolts AN73 Through AN81



AN73 (MS20073)	$\frac{3}{16}$ Diameter
AN74 (MS20074)	$\frac{4}{16}$ ($\frac{1}{4}$) Diameter
AN75 (MS20075)	$\frac{5}{16}$ Diameter
AN76 (MS20076)	$\frac{6}{16}$ ($\frac{3}{8}$) Diameter
AN77 (MS20077)	$\frac{7}{16}$ Diameter
AN78 (MS20078)	$\frac{8}{16}$ ($\frac{1}{2}$) Diameter
AN79 (MS20079)	$\frac{9}{16}$ Diameter
AN80 (MS20080)	$\frac{10}{16}$ ($\frac{5}{8}$) Diameter
AN81 (MS20081)	$\frac{11}{16}$ Diameter

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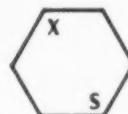
Material Identification by Bolt Head Markings



Special Bolt



Drilled Head Bolt



Special Bolt



NAS Close Tolerance Bolt



Magnetically Inspected



Orange-Dyed Magnetic Inspected



Clevis Bolt



Reworked Bolt



Aluminum Alloy (2024) BOLT



AN Standard Steel Bolt



AN Standard Steel Bolt



AN Standard Steel Bolt



Low Strength Bolt



AN Standard Steel Bolt



AN Standard Steel Bolt



AN Standard Steel Bolt



AN Standard Corrosion Resist. Steel Bolt



AN Standard Steel Bolt



AN Standard Steel Bolt



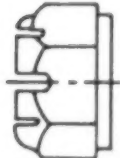
Special Bolt

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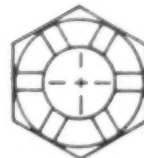
TM #13

G104C-47

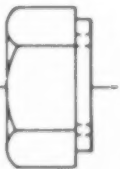
Standard Aircraft Nuts



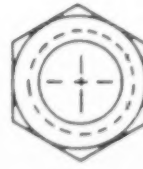
AN310 aircraft castle nut



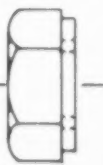
AN320 shear castle nut



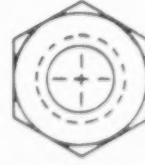
AN315 aircraft plain nut



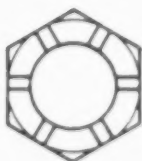
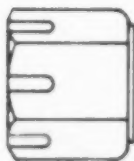
AN316 aircraft check nut



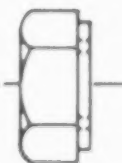
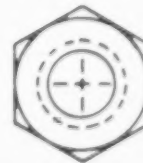
AN340 machine screw
nut-coarse thread



AN345 machine screw
nut-fine thread



AN355 slotted engine nut



AN360 plain engine nut

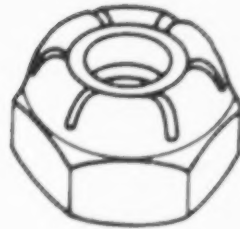


AN350 wing nut

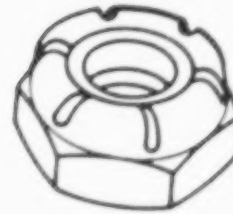
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TM #14

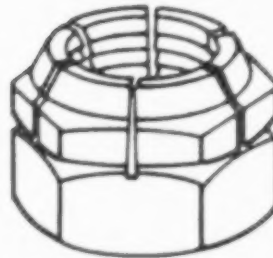
Self-Locking Nuts



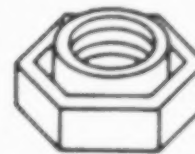
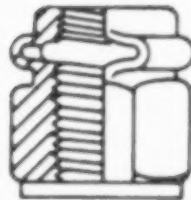
(A)



(B)



(C)



A — AN365 (MS20365) Low-Temperature Self-Locking Nut

B — AN364 (MS20365) Low-Temperature Shear Self-Locking Nut

C — AN363 High-Temperature Self-Locking Nuts

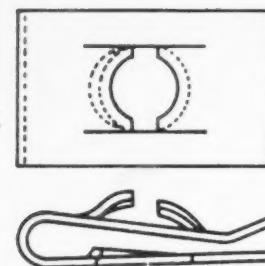
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TM #15

Tinnerman Nuts



Instrument Mounting Nut



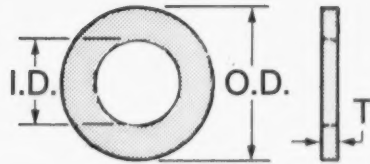
U-Type Tinnerman Nut



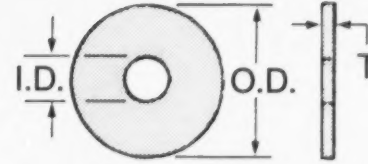
Anchor-Type Tinnerman Nut

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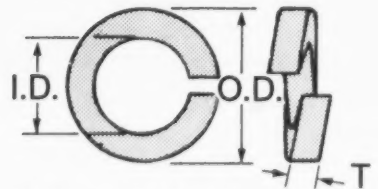
Aircraft Washers



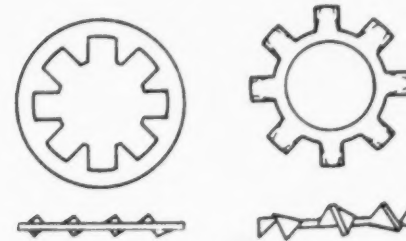
AN960 Plain Washer



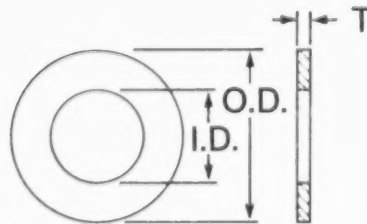
AN970 Large Area Washer



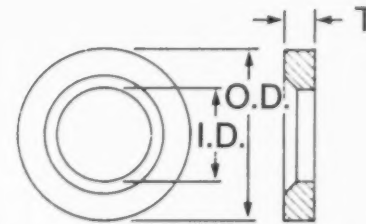
AN935 Split Lock Washer



AN936 Shakeproof Lock Washer



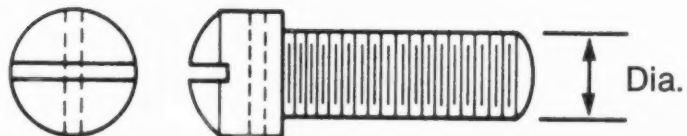
MS20002 High Strength
Plain Washer



MS20002 High Strength
Countersunk Washer

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Fillister-Head Machine Screws



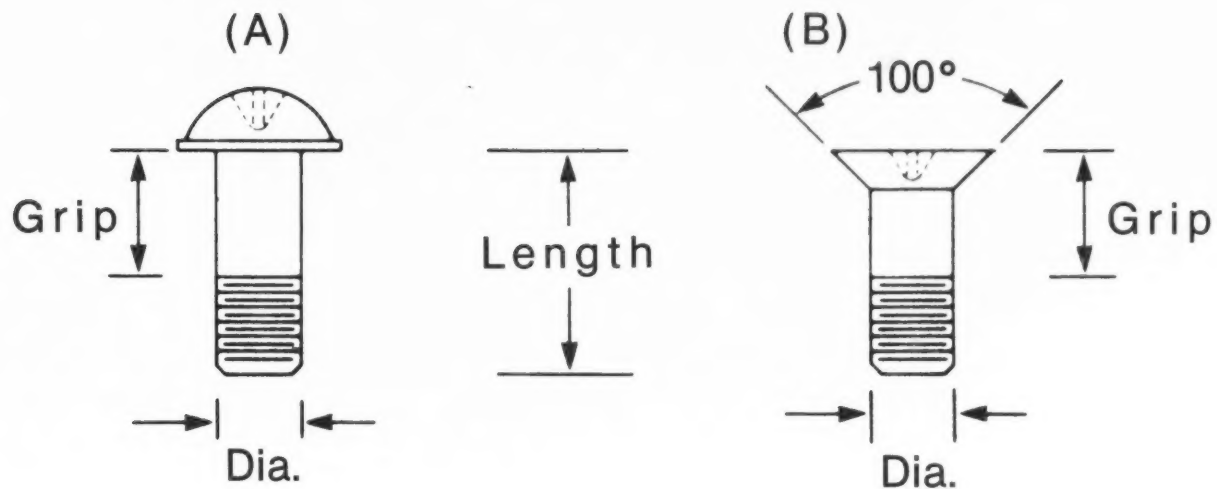
AN500 MS35265	AN501 MS35266	AN502	AN503
2-56	—	—	—
3-48	—	—	—
4-40	—	—	—
5-40	—	—	—
6-32	—	—	6-32
8-32	—	—	8-32
10-24	10-32	10-32	—
1/4-20	1/4-28	1/4-28	1/4-20
5/16-18	5/16-24	5/16-24	5/16-18
3/8-24	3/8-24	—	—

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G104C-57

TM #18

Measurement Nomenclature of Structural Screws



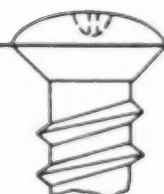
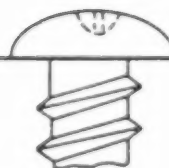
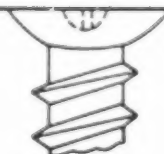
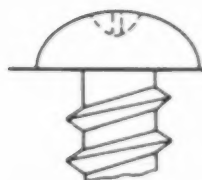
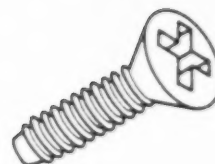
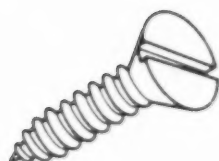
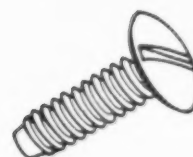
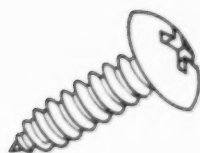
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Machine Screws

(A) 82 DEG	(B) 100 DEG	(C) 82 DEG	(D)	(E)	(F)
					
AN505 MS35109	AN507 MS24693	AN510	AN515 MS35206 MS35214	AN520 MS35215	AN526
—	—	0-80	—	0-80	—
—	—	1-72	—	1-72	—
—	—	2-64	—	2-64	—
2-56	—	—	2-56	—	—
—	—	3-56	—	3-56	—
3-48	—	—	3-48	—	—
—	4-48	4-48	—	4-48	—
4-40	4-40	—	4-40	—	—
—	—	5-44	—	5-44	—
5-40	—	—	5-40	—	—
—	6-40	6-40	—	6-40	6-40
6-32	6-32	—	6-32	—	6-32
—	8-36	8-36	—	8-36	8-36
8-32	8-32	—	8-32	—	8-32
—	10-32	10-32	—	10-32	10-32
10-24	10-24	—	10-24	—	10-24
—	1/4-28	1/4-28	—	1/4-28	1/4-28
1/4-20	1/4-20	—	1/4-20	—	1/4-20
—	5/16-24	—	—	—	—
5/16-18	5/16-18	—	5/16-18	—	—
—	3/8-24	—	—	—	—
3/8-16	3/8-16	—	3/8-16	—	—

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Self-Tapping Sheet Metal Screws



Round Head

100° CSK
Head

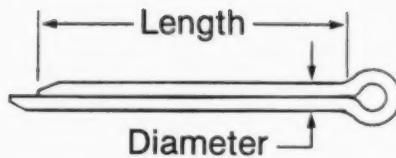
Truss
Head

Countersunk
Oval Head

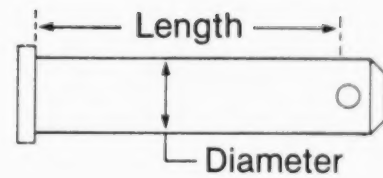
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TM #21

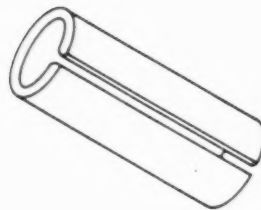
Pins



Cotter Pin



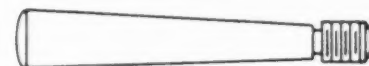
Clevis Pin



Spring Steel Rollpin



Plain Taper

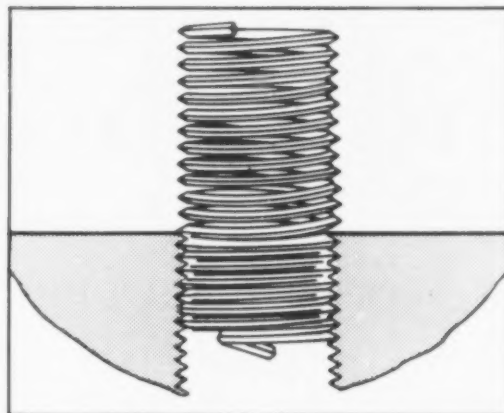


Threaded Taper Pin

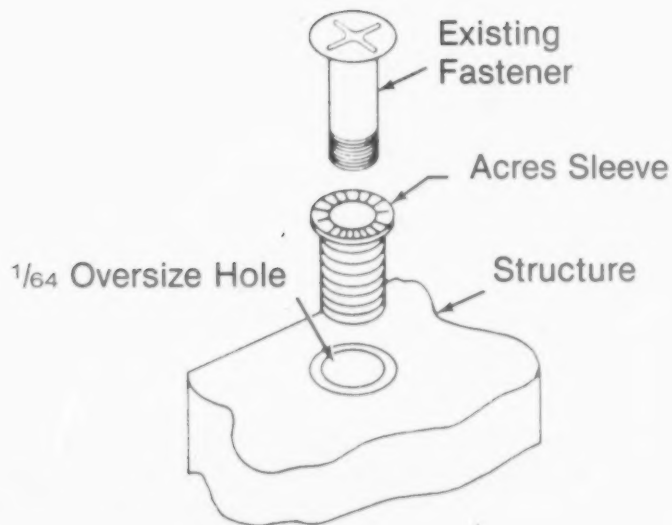
Taper Pins

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Hole Repair Hardware



Helicoil Insert



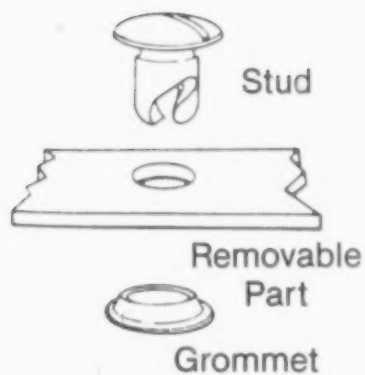
Acres Sleeve

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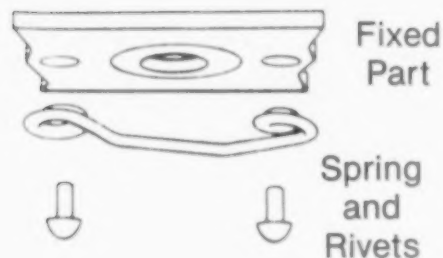
TM #23

G104C-67

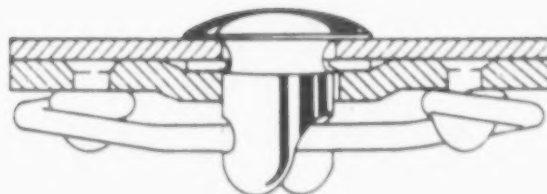
Parts of the Dzus Fastener



Stud Assembly



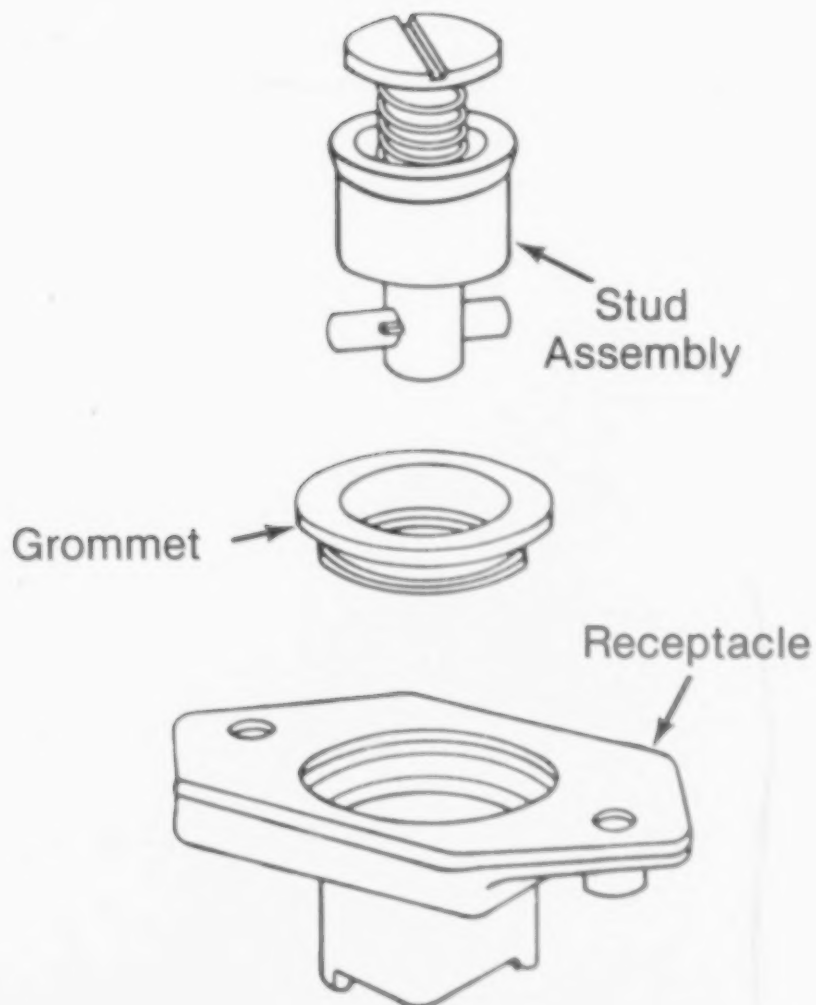
Spring Assembly



Installed Dzus Fastener

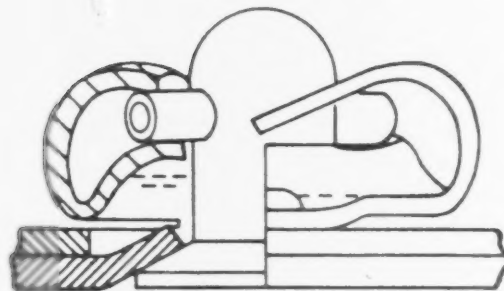
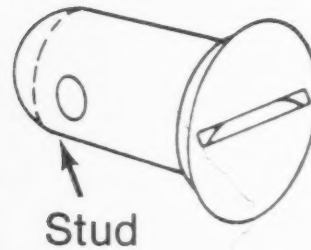
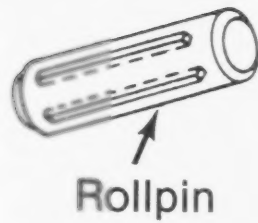
Used with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Parts of a Camlock Fastener

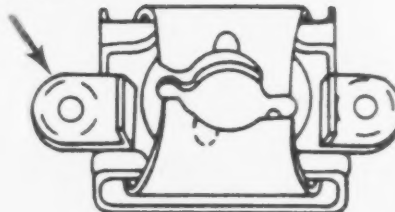


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Parts of an Airlock Fastener



Receptacle

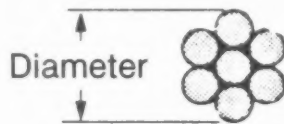


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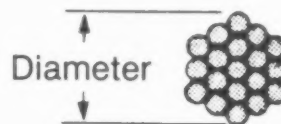
TM #26

G104C-73

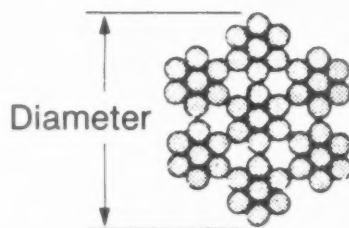
Construction of Aircraft Cable



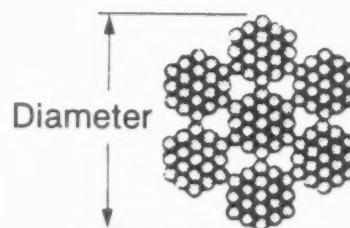
(A)



(B)



(C)



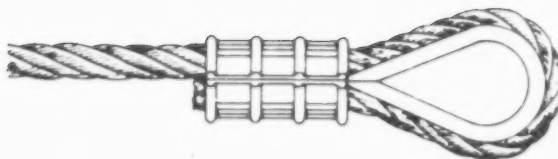
(D)

Cable Size	Type	Breaking Strength — Lbs.	
		Galvanized	Stainless
1/16"	1 × 7	500	500
	7 × 7	480	480
3/32"	1 × 19	1200	1200
	7 × 7	920	920
1/8"	1 × 19	2100	2100
	7 × 19	2000	2000
5/32"	1 × 19	3300	3300
	7 × 19	2800	2400
1/4"	1 × 19	8200	8200
	7 × 19	7000	6400

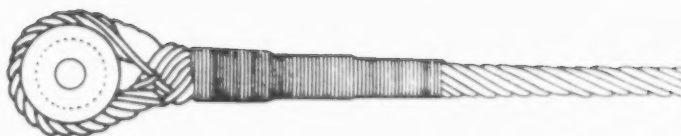
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TM #27

Cable Terminals



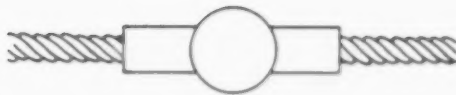
Nicopress Press Oval Sleeve



Army-Navy Five Tuck Splice

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Swaged Cable Terminals



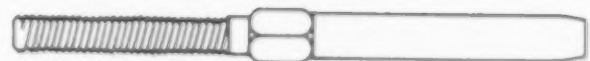
Ball and Double Shank



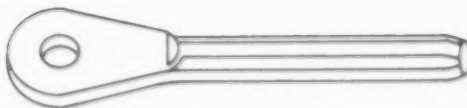
Ball and Single Shank



Long-Threaded Stud End



Short-Threaded Stud End



Eye End



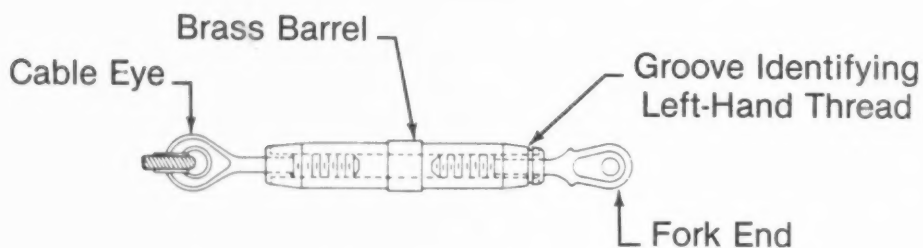
Fork End

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TM #29

G104C-79

Turnbuckle Nomenclature



Assembled Turnbuckle



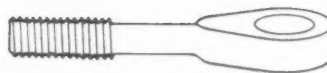
Turnbuckle Barrel



Turnbuckle Fork



Turnbuckle Pin Eye



Turnbuckle Cable Eye

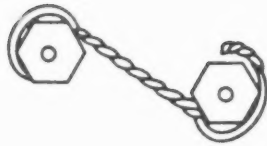


Woven Splices Connected with a Turnbuckle

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TM #30

Examples of Safetying



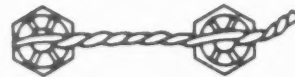
Safetying Together Two
Drilled Head Bolts



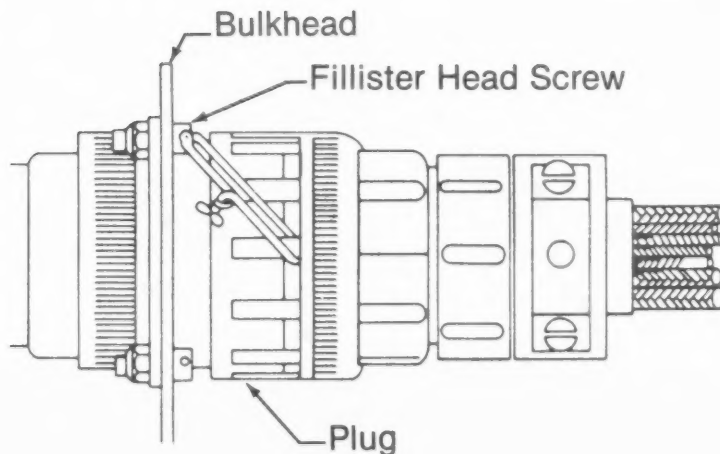
Safetying Together Three
Drilled Head Bolts



Safetying a Fillister Head
Screw to the Structure



Safetying Castellated Nuts
on Two Studs

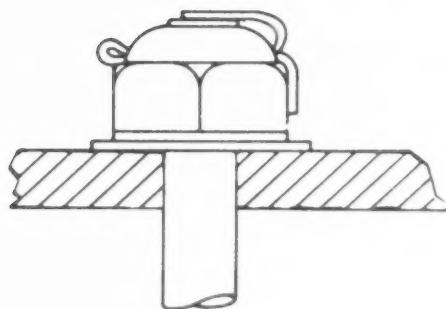


Safetying an Electrical Plug
to a Fillister Head Screw

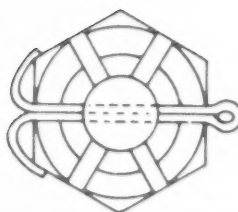
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TM #31

Safetying a Cotter Pin Installation



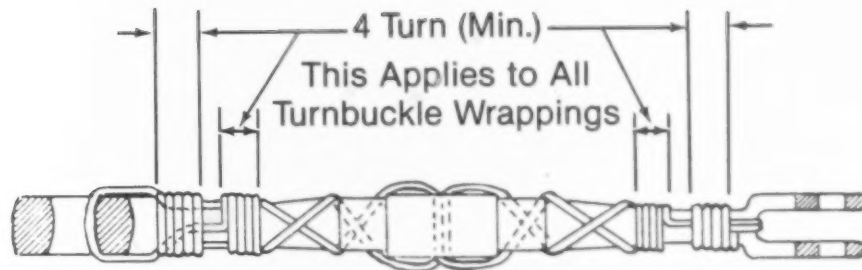
Preferred Method



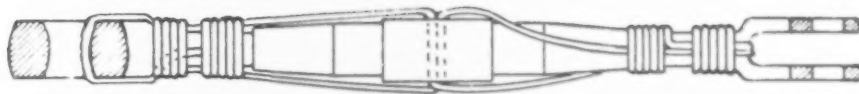
Alternate Method

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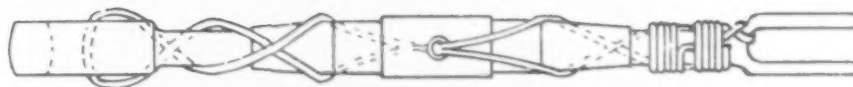
Safetying Turnbuckles



(A) Double Wrap (Spiral)



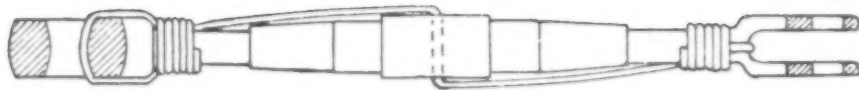
(B) Double Wrap



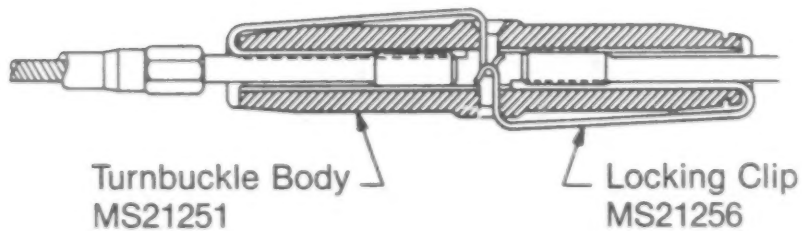
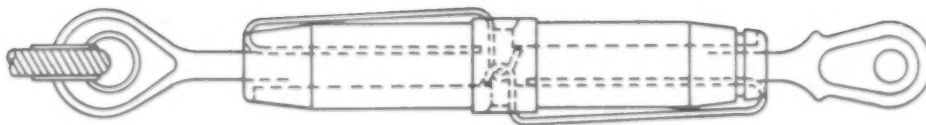
(C) Single Wrap (Spiral)

Safetying Turnbuckles

(Continued)



(D) Single Wrap



Clip Type Locking Device

GENERAL
G104 TECHNICAL MECHANICS
IDENTIFY AND SELECT AIRCRAFT HARDWARE
G104-C

PROJECT GUIDE #1--Fabricate a Nicopress Oval Sleeve Cable Terminal

PURPOSE: To develop skills in selecting the tools and necessary hardware for a Nicopress cable terminal, cutting aircraft cable, swaging the Nicopress oval sleeve properly, and inspecting the completed assembly to determine airworthiness.

REFERENCE MANUAL: AC 43.13-1A and 2A

EQUIPMENT AND TOOLS NEEDED:

A. 1/2-inch flat cold chisel

(NOTE: Cable cutters are optional.)

B. Nicopress swaging tool

C. Ball peen hammer

D. Diagonal pliers (dikes)

E. Small three-square file

F. Tape measure

G. Terminal gauge

SUPPLIES AND MATERIALS:

A. Shop supply of 1/8" 7 X 7 carbon steel cable

B. 4 Nicopress oval sleeves (28-3-M or 18-3-M)

C. 4 thimbles for 1/8" cable

D. Masking tape

PROJECT GUIDE #1

PROCEDURE:

- A. Measure a 12-inch length of cable from shop supply; wrap cable with masking tape at this point and mark the tape to indicate a 12-inch length (Figure 1)

FIGURE 1



- B. Support cable on a solid metal surface suitable for pounding (Figure 2)

FIGURE 2



PROJECT GUIDE #1

- C. Cut cable at 12-inch mark with cold chisel and ball peen hammer (Figure 3) or cable cutters

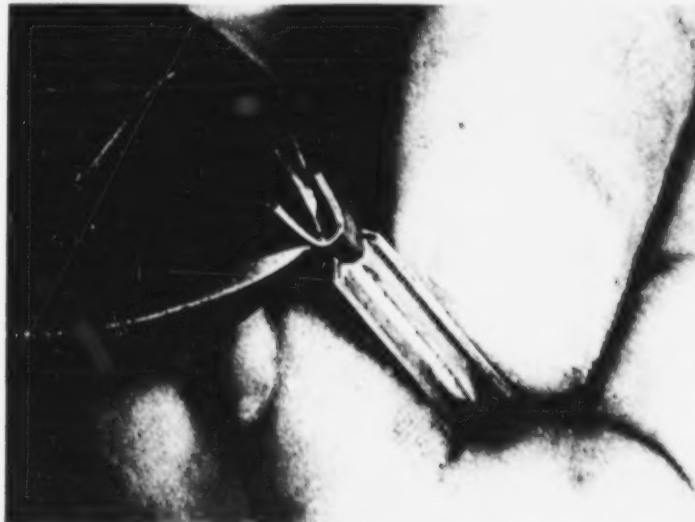
FIGURE 3



- D. Remove tape from cable carefully

- E. Using diagonal pliers, snip points from thimbles (Figure 4)

FIGURE 4



PROJECT GUIDE #1

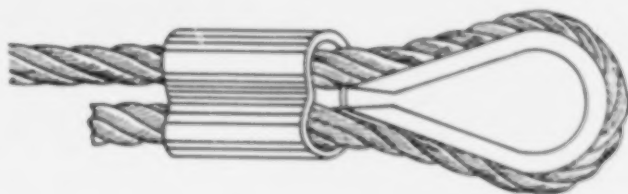
F. Dress ends of thimbles using small three-square file (Figure 5)

FIGURE 5



G. Insert cable through sleeve, around thimble, and back through sleeve; position cable so end will extend slightly beyond sleeve, as sleeve will elongate somewhat when compressed (Figure 6)

FIGURE 6



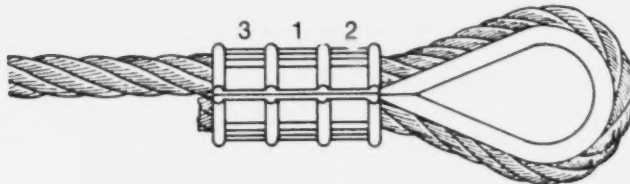
H. Refer to chart in AC 43.13-1A and 2A, page 103, figure 4.8 for correct number of presses to be used on 1/8-inch cable sleeves

PROJECT GUIDE #1

- I. Make proper number of presses in correct order using Nicopress swaging tool (Figure 7)

(NOTE: For this step it will be necessary to have some assistance. Two people working together will insure a high-quality terminal end.)

FIGURE 7



(NOTE: To compress a sleeve, have it well-centered in the tool groove with the major axis of the sleeve at right angles to the tool. If the sleeve appears to be out of line after the press is started, open the tool, re-center the sleeve, and complete the press. [See Figure 8 for major axis.]

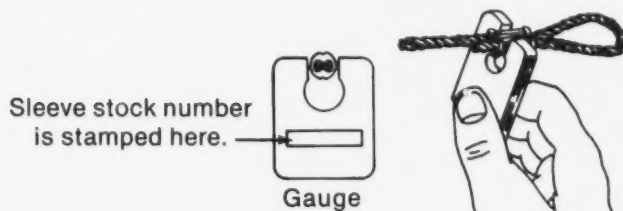
FIGURE 8



- J. After swaging of sleeve is completed, check dimension of major axis with terminal gauge (Figure 9); check sleeve length after compression and compare it to required length in AC 43.13-1A and 2A, page 103, figure 4.8

(NOTE: An airworthy terminal must fit into the terminal gauge.)

FIGURE 9



PROJECT GUIDE #1

- K. Repeat procedures in steps A-J for opposite end of cable
- L. Using established methods, cut both cable terminals off and repeat procedures in steps A-J
- M. Turn in all Nicopress oval sleeve cable terminals to instructor for evaluation
- N. Return equipment and materials to instructor

GENERAL
G104 TECHNICAL MECHANICS
IDENTIFY AND SELECT AIRCRAFT HARDWARE
G104-C

PROJECT GUIDE #2--Identify, Select, and Install Aircraft Hardware

PURPOSE: To develop skill in identifying, selecting, and installing specific aircraft hardware.

REFERENCE MANUALS:

- A. AC 43.13-1A and 2A
- B. AC 65-9A
- C. Standard Aircraft Handbook

EQUIPMENT AND TOOLS NEEDED:

- A. Hardware board and accessory box
- B. 1 set of end wrenches
- C. 1/4-inch drive torque wrench
- D. 6-inch rule or AN bolt gauge and grip length gauge
- E. Thread pitch gauge
- F. Set of 1/4-inch drive sockets

SUPPLIES AND MATERIALS: 4-inch piece of masking tape

PROCEDURE:

(NOTE: The end wrenches will be used to aid in the installation of hardware items. The 6-inch rule will be used for determining length of hardware and the thread pitch gauge will be used for determining the pitch of the threaded fastener. The sketch provided with this project guide and the Parts List are to be used for reference on all steps.)

- A. For holes 1-10 of Block A, select hardware from accessory box using Parts List and Standard Aircraft Handbook as your guide; write names of hardware items, as found in Standard Aircraft Handbook, in "Nomenclature" space provided on Parts List

PROJECT GUIDE #2

- B. Install hardware for holes 1-10 of Block A on hardware board and torque nuts using torque wrench and correct socket to 50-70 inch-pounds

(NOTE: See page 135 in AC 65-9A [Torque Tables] for torquing instructions. The Parts List will provide the order for the assembly. The heads of the bolts will go on the front side of the hardware board.)

- C. For holes 1-3 of Block B select hardware from accessory box using Parts List and the Standard Aircraft Handbook as your guide; write names of hardware items, as found in Standard Aircraft Handbook, in "Nomenclature" space provided on Parts List

- D. Install hardware for holes 1-3 on Block B and torque nuts to 30-40 inch-pounds

(NOTE: See page 135 in AC 65-9A [Torque Tables and Cotter Pin Line-Up] for additional instructions. **Do not cotter pin at this time.** The Parts List will provide the order for the assembly. The heads of the bolts are to be placed on the back of the hardware board. Blocks BB and AA must be installed while installing the hardware for Block B according to the sketches provided in the project guide. Continue to insure correct alignment of Blocks BB and AA while installing hardware in Blocks C and D.)

- E. For holes 1-4 of Block C follow procedure outlined in step A

- F. Install hardware for holes 1-4 of Block C on hardware board and torque assemblies in holes 1 and 2 to 50-70 inch-pounds; torque assemblies in holes 3 and 4 to 20-25 inch-pounds

- G. For holes 1-3 of Block D follow procedure outlined in step A

- H. Install hardware for holes 1-3 of Block D on hardware board and torque assembly in hole 1 to 100-140 inch-pounds; torque assembly in hole 2 to 160-190 inch-pounds; torque assembly in hole 3 to 50-70 inch-pounds; see the note after step B for further instructions

- I. For holes 1-6 of Block E follow procedure outlined in step A

- J. Install hardware for holes 1-6 of Block E on hardware board and install the turnbuckle assemblies; the heads of the machine screws will be placed to the back of board

(NOTE: The completed turnbuckle ends should have a nut on both sides. No torquing is required on these assemblies.)

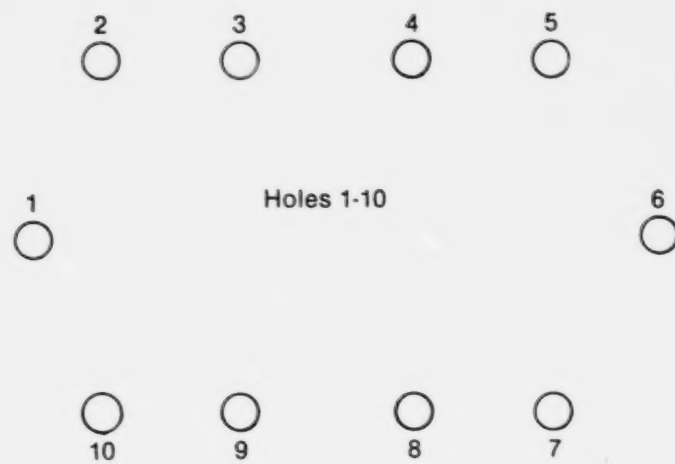
- K. For holes 1X, 2X, 3X, and 4X of Block F follow procedure outlined in step A

(NOTE: Holes 1X and 2X are in both the hardware board and Flange X. Holes 3X and 4X are in Flange X and Plate F1.)

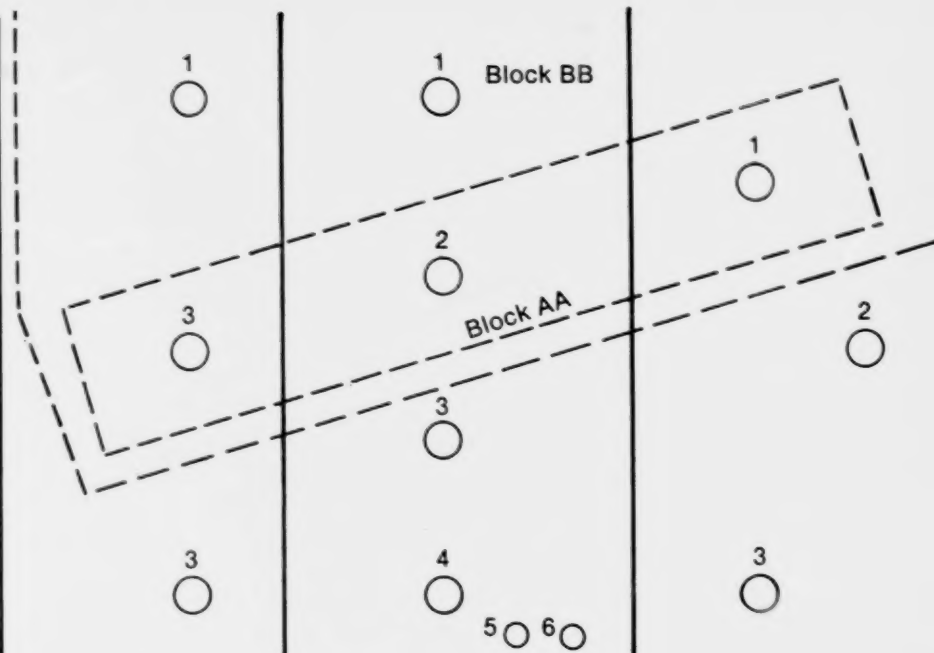
PROJECT GUIDE #2

- L. Mount Flange X on hardware board using selected hardware according to sketch and assembly order specified in Parts List
- M. Attach Plate F1 to Flange X using appropriate hardware

(NOTE: Make sure that hole 3X on Flange X is countersunk properly to receive the fastener.)
- N. Select from remaining fasteners in accessory box correct hardware for holes 1-4 of Block G; write names of hardware items in "Nomenclature" space provided on Parts List
- O. Insert fasteners for holes 1-4 of Block G into proper holes and secure them with masking tape



A

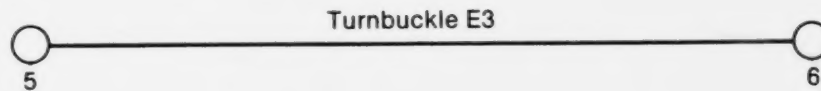
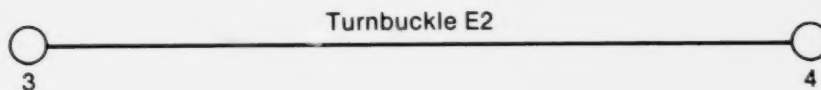
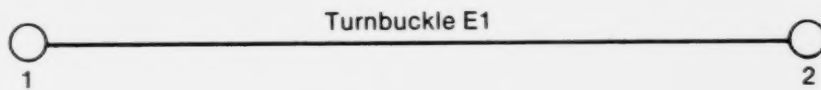


B

C

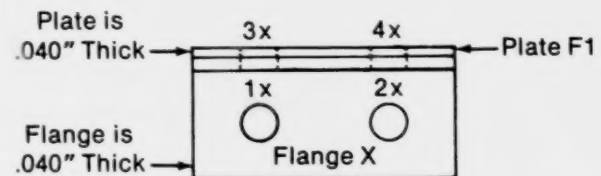
D

G104C-101

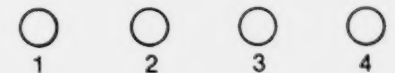


E

SKETCH #1



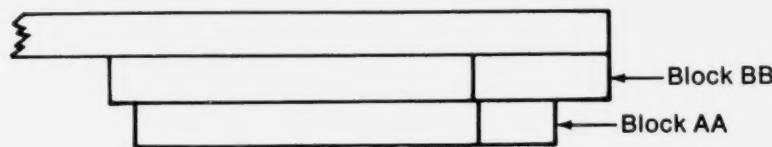
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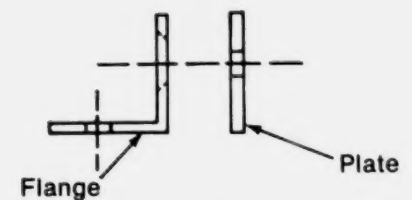
G

FRONT

H



View Looking From The Right



PROJECT GUIDE #2 - Parts List

PART	QUANTITY	NOMENCLATURE
BLOCK A.		
<u>#1-10 Holes</u>		
Bolt: AN4H-5A	(10)	_____
Washers:		
Head Side: AN960-416	(10)	_____
Nut Side: AN935-416L	(10)	_____
Nut: AN315-4		
BLOCK B.		
<u>#1 Hole</u>		
Bolt: AN24-10	(1)	_____
Washers:		
Head Side: AN970-4	(1)	_____
Nut Side: AN960-416	(1)	_____
Nut: AN310-4	(1)	_____
<u>#2 Hole</u>		
Bolt: AN4-11	(1)	_____
Washers:		
Head Side: AN970-4	(1)	_____
Nut Side: AN960-416	(1)	_____
Nut: AN310-4	(1)	_____

PROJECT GUIDE #2 - Parts List

PART	QUANTITY	NOMENCLATURE
<u>#3 Hole</u>		
Bolt: AN43-5	(1)	_____
Washers:		
Head Side: AN970-4	(1)	_____
Nut Side: AN960-416	(1)	_____
Nut: AN310-4	(1)	_____
BLOCK C.		
<u>#1 Hole</u>		
Bolt: AN74-5	(1)	_____
Washers:		
Head Side: AN960A-416L	(1)	_____
Nut Side: AN960A-416L	(1)	_____
Nut: AN365-428C	(1)	_____
<u>#2 Hole</u>		
Bolt: AN74-11	(1)	_____
Washers:		
Head Side: AN960A-416L	(1)	_____
Nut Side: AN960A-416L	(1)	_____
Nut: AN365-428C	(1)	_____
<u>#3 Hole</u>		
Bolt: AN73-5	(1)	_____
Washers:		
Head Side: AN960-10	(1)	_____
Nut Side: AN960-10	(1)	_____
Nut: AN365-1032C	(1)	_____

PROJECT GUIDE #2 - Parts List

PART	QUANTITY	NOMENCLATURE
<u>#4 Hole</u>		
Bolt: AN173H-10A	(1)	_____
Washers:		
Head Side: AN960-10	(1)	_____
Nut Side: AN960-10	(1)	_____
Nut: AN365-1032C	(1)	_____
BLOCK D.		
<u>#1 Hole</u>		
Bolt: AN5H-11A	(1)	_____
Washers:		
Head Side: AN970-5	(1)	_____
Nut Side: AN960-516	(1)	_____
Nut: AN350-4	(1)	_____
<u>#2 Hole</u>		
Bolt: AN6DDH-5A	(1)	_____
Washers:		
Head Side: AN970-6	(1)	_____
Nut Side: AN960-616	(1)	_____
Nut: AN365-624A	(1)	_____
<u>#3 Hole</u>		
Bolt: AN4CH-5A	(1)	_____
Washers:		
Head Side: AN970-4	(1)	_____
Nut Side: AN960-416	(1)	_____
Nut: AN365-428C	(1)	_____

PROJECT GUIDE #2 - Parts List

PART	QUANTITY	NOMENCLATURE
BLOCK E.		
<u>#1 and #2 Holes</u>		
Screw: AN502-10-16	(2)	-----
<u>#3 and #4 Holes</u>		
Screw: AN525-1032-16	(2)	-----
<u>#5 and #6 Holes</u>		
Screw: AN520-10-16	(2)	-----
(NOTE: All screws in block E will use an "AN 970-3" washer on the head and nut side and an "AN 315-3" nut on each screw. The remaining AN 315-3 nuts will be placed on the screws after the turnbuckle assemblies are mounted.)		
Washers:		
AN970-3	(12)	-----
AN315-3	(12)	-----
Turnbuckle Assemblies:		
E1 AN130-165	(1)	-----
E2 AN135-165	(1)	-----
E3 AN150-165	(1)	-----
BLOCK F.		
<u>ATTACHMENTS FOR FLANGE X TO HARDWARE BOARD</u>		
<u>Hole 1X and 2X</u>		
Screw: AN525-8-8	(2)	-----
Washer: AN960-8	(2)	-----
Nut: AN365-836C	(2)	-----

PROJECT GUIDE #2 - Parts List

PART	QUANTITY	NOMENCLATURE
BLOCK F.(continued)		

ATTACHMENTS FOR PLATE F1 to FLANGE X

Hole 3X

Screw: AN531-6-5	(1)	_____
------------------	-----	-------

Hole 4X

Screw: AN530-6-5	(1)	_____
------------------	-----	-------

Washer: AN936A-6	(1)	_____
------------------	-----	-------

BLOCK G.

#1 Hole

AN426DD3-5	(1)	_____
------------	-----	-------

#2 Hole

AN430A4-6	(1)	_____
-----------	-----	-------

#3 Hole

AN442D5-8	(1)	_____
-----------	-----	-------

#4 Hole

AN470AD-3-5	(1)	_____
-------------	-----	-------

GENERAL
G104 TECHNICAL MECHANICS
IDENTIFY AND SELECT AIRCRAFT HARDWARE
G104-C

PROJECT GUIDE #3--Safety Aircraft Hardware

PURPOSE: To develop skill in lockwiring and installing cotter pins.

REFERENCE MANUALS:

- A. AC 65-9A, pages 145-150
- B. AC 43.13 1A and 2A, pages 112-114

EQUIPMENT AND TOOLS NEEDED:

(NOTE: Various pliers in the tool list will be used as the situation requires or allows. Your instructor will specify allowable usages.)

- A. Completed hardware board from Project Guide #2 and accessory box
- B. Duckbill pliers
- C. Diagonal pliers
- D. Needlenose pliers
- E. Safety wire pliers (optional)

SUPPLIES AND MATERIAL:

- A. Shop supply of 0.032" stainless steel safety wire
- B. Shop supply of cotter pins

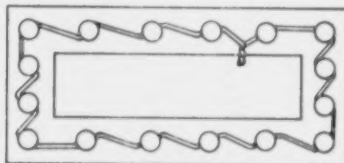
PROCEDURE:

(NOTE: This procedure should not be attempted until you have seen instructor's demonstration on safety wiring. Apply all safety procedures related to FOD.)

(NOTE: Apply all safety procedures related to FOD.)

- A. Safety fasteners in Block A using single-wire method and 0.032" safety wire (Figure 10)

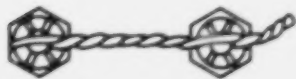
FIGURE 10



PROJECT GUIDE #3

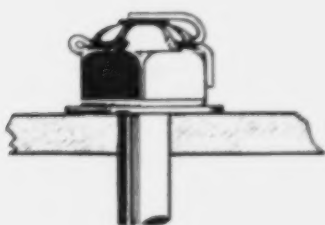
- B. Safety fasteners in holes 1 and 2 in Block B using double-twist method and 0.032" safety wire (Figure 11)

FIGURE 11



- C. Safety fastener in hole 3 of Block B using a cotter pin (Figure 12)

FIGURE 12



- D. Safety fasteners in holes 1, 2, and 3 of Block C using double-twist method and 0.032" safety wire (Figure 13)

FIGURE 13



- E. Safety fastener in hole 4 of Block C using double-twist method and 0.032" safety wire (Figure 14)

(NOTE: Have wire run through holes 5 and 6 and then double-twist to fastener in hole 4.)

FIGURE 14



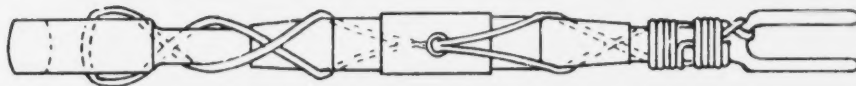
PROJECT GUIDE #3

- F. Safety fasteners in holes 1-3 of Block D using double-twist method and 0.032" safety wire
- G. Safety all turnbuckles in Block E using single-wrap method (Figure 15)
- (NOTE: Use the single wrap on one and the single wrap [spiral] on the remaining two.)

FIGURE 15



SINGLE WRAP

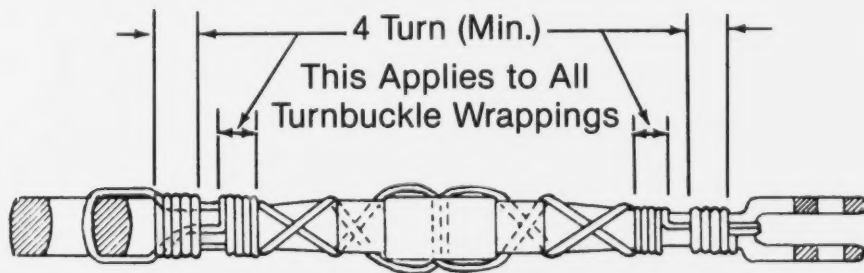


SINGLE WRAP (SPIRAL)

- H. Have instructor check your work before proceeding
- I. Remove safety wire from turnbuckles and resafety using double wrap methods (Figure 16)

(NOTE: Use the plain double wrap on one of the turnbuckles and the double wrap [spiral] on the remaining two.)

FIGURE 16



DOUBLE-WRAP (SPIRAL)



DOUBLE WRAP

PROJECT GUIDE #3

- J. Have instructor check your work
- K. Return equipment and materials to instructor

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IDENTIFY AND SELECT AIRCRAFT HARDWARE
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THEORY TEST

1. Match terms related to aircraft hardware to their correct definitions. Write the correct numbers in the blanks.

- | | | |
|----------|---|---------------------------|
| _____ a. | Connecting fitting attached to the end of a cable | 1. Fastener |
| _____ b. | Nuts, bolts, screws, rivets, washers, locking devices, and other small items used to assemble aircraft parts | 2. Nut |
| _____ c. | Fastener with high tensile and shear strengths attained through combinations of materials, work-hardening, and heat treatment | 3. Pin |
| _____ d. | Internally threaded collar that screws onto bolts or screws to form a complete fastening device | 4. Bolt |
| _____ e. | Straight cylindrical or tapered fastener, designed to perform an attaching or locating function | 5. Washer |
| _____ f. | Small metal pin with a specially formed head on one end, used to fasten sheet metal parts together by upsetting the shank to form a clamping head | 6. Thread pitch |
| _____ g. | Distance from the peak of one thread to the peak of the next thread on a screw, bolt, or other thread fitting | 7. High-strength fastener |
| _____ h. | Flat metal disc with a central hole, used to provide a smooth surface for a nut or bolt to seat against and to shim between a nut and the surface to compensate for an improper grip length of the bolt | 8. Hardware |
| _____ i. | Externally threaded fastener | 9. Cable terminal |
| _____ j. | Device used to fasten two objects together | 10. Rivet |

THEORY TEST

- k. Length of a chord passing through the center of a circular body
- l. Specially designed steel cable connected to linkages used in flight control systems and engine controls
- m. Special rivet designed to be used where it is not possible to use a bucking bar for riveting
- n. Installation of any type of device that prevents the loosening of an attachment
- o. Method of fastening bolt- or screw-heads together with soft wire to prevent them from becoming loose
- p. Hollow, blind rivet in which the inside of the shank is threaded, and the upset rivet may be used as a blind nut
- q. Special-purpose bolt whose round head is slotted or recessed to accept a screwdriver, having a very short threaded portion on the shank and used only for shear loads
- r. Hex-head aircraft bolt whose shank has been centerless ground to a tolerance of +0.000 -0.0005 inch
- s. High-strength steel bolt with a recessed head designed for tensile loads
- t. Internally threaded collar with a mechanical means to prevent loosening
- 11. Self-locking nut
- 12. Clevis bolt
- 13. Rivnut
- 14. Close-tolerance bolt
- 15. Diameter
- 16. Blind rivet
- 17. Safetying
- 18. Safety wiring
- 19. Internal wrenching bolt
- 20. Control cable

THEORY TEST

- | | | |
|-----------|---|----------------------|
| _____ u. | Rivets made of 2024 or 2017 aluminum alloy, which must be heat-treated, quenched, and held in a subzero icebox until they are driven | 21. Anchor nut |
| _____ v. | Patented, threadless bolt used in the production of aircraft where high-strength, high-speed, light-weight fasteners are required | 22. Helicoil |
| _____ w. | Special form of threadless bolt composed of a steel pin held into the structure by an aluminum or mild-steel collar swaged into a groove around the end of the pin | 23. Huck Lockbolt |
| _____ x. | Trade name registered for a particular type of internally threaded three-piece rivet | 24. High-shear rivet |
| _____ y. | Device used in a control system to adjust cable tension, consisting of a brass barrel with both left- and right-hand threaded terminals | 25. Jo-bolts |
| _____ z. | Pure aluminum to which one or more alloying elements has been added to increase its hardness, toughness, durability, and resistance to fatigue | 26. Aluminum alloy |
| _____ aa. | Patented form of cowling fastener in which a slotted stud is forced over a spring-steel wire and rotated to lock the wire in a cam-like groove | 27. Turnbuckle |
| _____ bb. | Fastener which differs in any respect from recognized standards | 28. Dzus fastener |
| _____ cc. | Registered trade name for a special helical steel insert that is screwed into specially cut threads to restore threads that have been stripped out or to provide durable threads in soft castings | 29. Special fastener |
| _____ dd. | Self-locking nut which has a lug or lugs for attachment | 30. Icebox rivets |

THEORY TEST

2. Identify aircraft rivets by alloy, specification code, symbol, and head marking. Fill in the missing information in the chart below.

ALLOY	SYMBOL	HEAD MARK
a. _____	A	_____
b. 2117 aluminum	_____	_____
c. _____	D	_____
d. 2024 aluminum	_____	_____
e. _____	B	_____
f. _____	_____	Double Dimple

3. State facts related to general use of aircraft rivets. Write the correct answers in the blanks. Only a short answer is required.

- a. What should be done if a 2024 alloy rivet is not driven within 10 minutes after having been quenched?

- b. Why are A-type rivets not approved for aircraft structural use?

- c. What are the two alloys used in icebox rivets?

1) _____

2) _____

- d. Why must an icebox rivet be kept at a subfreezing temperature after it has been heat-treated?

THEORY TEST

- e. What are the two ways an upset head may be formed on a conventional rivet?

- 1) _____
2) _____

4. Match the four general use aircraft rivet head designs to their correct AN specification numbers. Write the correct numbers in the blanks.

_____ a. AN470

1.



_____ b. AN426

2.



_____ c. AN442

3.



_____ d. AN430

4.



5. Select true statements related to special rivets. Circle the letter before each correct statement.

- a. When only one end of a rivet is accessible for installation, conventional rivets may be installed using compression from a squeeze-riveting machine
- b. Two types of blind rivets are self-plugging, friction-lock rivets and self-plugging, mechanical-lock rivets
- c. High-strength pin rivets are made of high-strength steel with a locking collar swaged into a groove in the shank, and therefore cannot be drilled out and replaced once they are installed

THEORY TEST

- d. High-shear rivets are useful for attaching landing gear or other applications where the strength of a bolt is needed
- e. Rivnuts are commonly used for attaching rubber de-icing boots to an aircraft wing or tail surface

6. Unless otherwise specified, state facts related to standard aircraft bolt types, thread fits, specification numbers, applications, and installations. Write the correct answers in the blanks.

- a. What condition should an aircraft bolt's threads be in when using specified torque values?

- b. How should an aircraft bolt be installed unless otherwise specified or required?

- c. What does a cross inside a triangle on the head of a bolt tell you about that bolt?

- d. How is a clevis bolt used with a fork-end cable terminal secured?

- e. What does a single raised dash on the head of a bolt tell you about that bolt?

- f. Generally speaking, how are bolt grip lengths usually determined?

THEORY TEST

g. What type of fit does an aircraft bolt usually have?

h. What would be the grip length for a bolt used to fasten two 5/8-inch steel plates together?

i. What type applications would an AN clevis bolt be used for in an airplane?

(NOTE: Write the correct answers in the blanks for the following statements.)

j. Almost all standard aircraft hardware uses the American National Standard Thread in either the _____ or the _____ series.

k. The specification number of a bolt identifies its diameter in _____-inch increments.

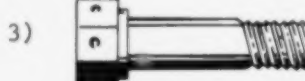
l. The dash number of these standard bolts indicates their length in _____-inch increments.

m. The FAA does not allow the use of steel bolts smaller than _____-inch or aluminum alloy bolts smaller than _____-inch for structural application.

n. High-strength steel bolts used primarily for tensile loads are _____ bolts.

7. Identify common aircraft bolts by head markings and head shapes.

a. Identify the clevis bolt in the following illustrations. Circle the number preceding the correct drawing.



THEORY TEST

- b. Which of the following bolt head code markings identifies a corrosion resistant AN standard steel bolt? Circle the number preceding the correct drawing.

1)



3)



2)



4)



- c. Identify the following bolt head markings. Write the correct bolt names in the blanks.

1)



2)



3)



4)



THEORY TEST

- d. Identify the following bolt head shapes. Write the correct bolt names in the blanks.

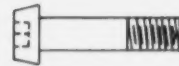
1) _____



2) _____

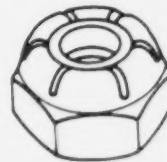


3) _____

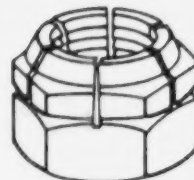


8. Identify the main types of nuts used in aircraft construction. Write the correct names of the nuts in the blanks. Do not use specification codes.

a. _____



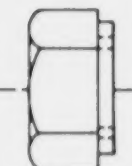
b. _____



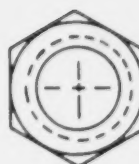
THEORY TEST



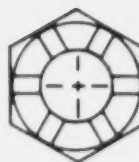
c. _____



d. _____



e. _____



f. _____

9. Select facts related to nuts used in aircraft construction. Circle the numbers before the correct answers.

a. A fiber-type, self-locking nut should never be used on an aircraft if the bolt is

- 1) under shear loading
- 2) under tension loading
- 3) subject to rotation
- 4) to be mounted in a vertical position

THEORY TEST

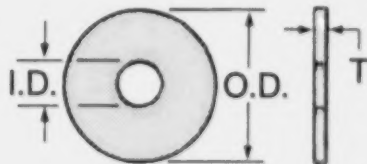
b. When the specific torque value for nuts is not given, where can the recommended torque value be found?

- 1) AC 43.12-2A
- 2) FAR Part 43, Appendix D
- 3) Technical Standard Order
- 4) AC 43.13-1A

c. How is the locking feature of the fiber-type lock nut obtained?

- 1) By a saw-cut fiber insert with a pinched-in thread in the locking section
- 2) By the use of an unthreaded fiber locking insert
- 3) By a fiber insert held firmly in place at the base of the load carrying section
- 4) By placing the threads in the fiber insert out-of-phase with the load carrying section

10. Identify the common types of washers used in aircraft construction. Write the correct washer names in the blanks.



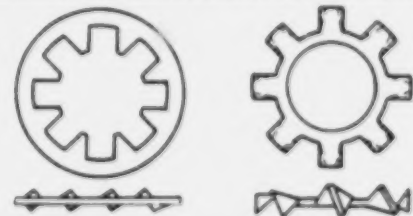
a. _____



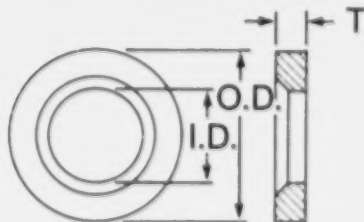
b. _____



c. _____



d. _____



e. _____

THEORY TEST

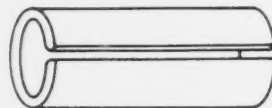
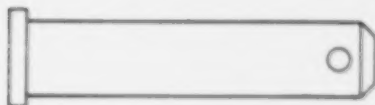
11. Identify the following washers by specification numbers and state their uses. Write the correct washer name in the blank following the AN numbers. State the washer usage below the bolt name.

- a. AN 955 - _____
Usage - _____
- b. AN 970 - _____
Usage - _____
- c. AN 960 - _____
Usage - _____
- d. AN 936 - _____
Usage - _____

12. List the three types of screws used in aircraft construction.

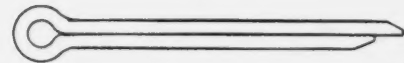
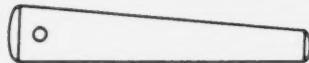
- a. _____
- b. _____
- c. _____

13. Identify the four types of pins commonly used in aircraft construction. Write the correct names of the pins in the blanks.



- a. _____
- b. _____

THEORY TEST



c. _____ d. _____

14. State facts related to both screws and pins used in aircraft construction. Write the correct answers in the blanks.

a. Are machine screws normally used for structural or non-structural applications? _____

b. What class fit are most machine screws? _____

c. How is an AN 509 structural screw distinguished from an AN 507 machine screw? _____

d. List the four types of heads available on self-tapping screws.

1) _____

2) _____

3) _____

4) _____

e. How is a roll pin held in the structure? _____

f. What type of pin is used to lock a castellated nut onto a drilled shank bolt? _____

g. Is the length of the cotter pin measured to the end of the long or the short leg? _____

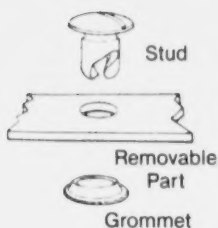
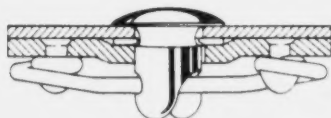
THEORY TEST

15. List the two uses of inserts for repairing threaded and unthreaded holes.

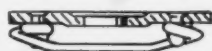
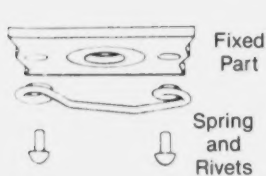
a. _____

b. _____

16. Identify the following Dzus, airlock, and Camlock fasteners. Write the correct fasteners' names in the blanks.



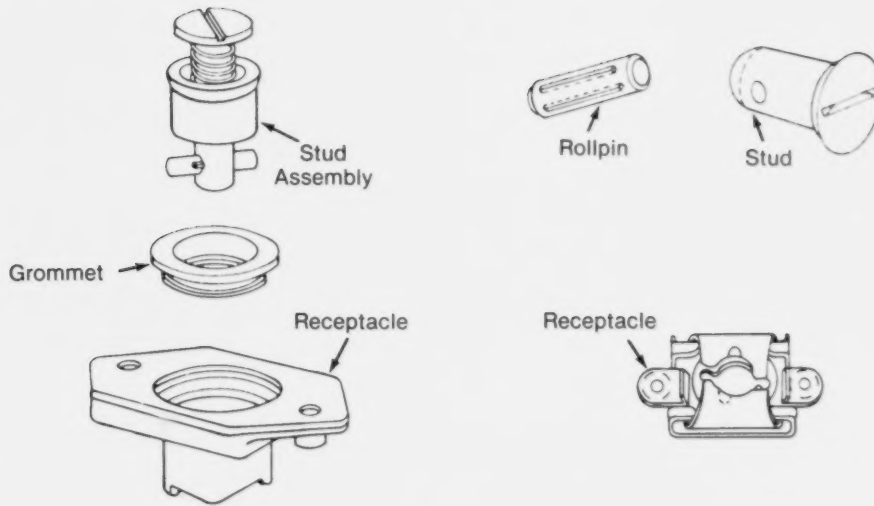
Stud Assembly



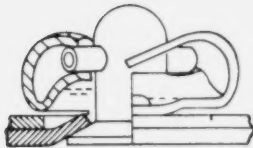
Spring Assembly

a. _____

THEORY TEST



THEORY TEST



c. _____

17. State facts related to Dzus, airlock, and Camlock fasteners. Write the correct answers in the blanks. Only a short answer is needed.

a. What is the purpose for Dzus, Airlock, and Camlock fasteners?

b. How can a mechanic know if a row of Dzus fasteners is properly locked?

c. How can a mechanic know if a Dzus fastener is damaged?

18. State facts related to aircraft cable and cable terminals. Write the correct answers in the blanks.

a. Why are automatic tensioning systems needed for the control cables of very large aircraft?

THEORY TEST

b. What are the two materials of which aircraft control cables are made?

1) _____

2) _____

c. How many wires are used in an extra-flexible control cable?

d. What percent of control cable strength does a swaged terminal produce?

19. Fabricate a Nicopress oval sleeve cable terminal.

(NOTE: Test question 19 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

20. State facts related to aircraft turnbuckles. Write the correct answers in the blanks.

a. What is the maximum number of threads that can be exposed on the ends of a turnbuckle for it to develop its full strength? _____

b. What is the significance of the groove in one of the ends of a turnbuckle barrel? _____

21. State facts related to safetying methods used in aircraft construction. Write the correct answers in the blanks.

a. When lock-wiring widely spaced groups, what is the maximum number of bolts that should be done in a series? _____

b. Which method is the most preferred method for safetying turnbuckles?

(NOTE: Test questions 22 and 23 are project guides. They are an important part of this test. If they have not been completed, check with your instructor.)

22. Identify, select, and install aircraft hardware.

23. Safety aircraft hardware.

GENERAL
G104 TECHNICAL MECHANICS
IDENTIFY AND SELECT AIRCRAFT HARDWARE
G104-C

ANSWERS TO THEORY TEST

- | | | |
|---------|-------|--------|
| 1. a. 9 | k. 15 | u. 30 |
| b. 8 | l. 20 | v. 23 |
| c. 7 | m. 16 | w. 24 |
| d. 2 | n. 17 | x. 25 |
| e. 3 | o. 18 | y. 27 |
| f. 10 | p. 13 | z. 26 |
| g. 6 | q. 12 | aa. 28 |
| h. 5 | r. 14 | bb. 29 |
| i. 4 | s. 19 | cc. 22 |
| j. 1 | t. 11 | dd. 21 |
2. a. 1100 aluminum; no mark
b. AD; dimple
c. 2017 aluminum; test
d. DD; two raised dashes
e. 5056 aluminum; raised cross
f. Monel; M
3. a. The rivet should be re-heat-treated
b. Rivets do not have the required strength for aircraft structure
c. 1) 2017
2) 2024
d. It will delay their aging or hardening
e. 1) Squeezing
2) Hammering
4. a. 2
b. 1
c. 4
d. 3
5. b, d, e
6. a. Threads should be dry and thoroughly degreased
b. Upward or in a forward direction
c. It is a close tolerance bolt
d. With a shear nut tightened to a snug fit, but with no strain imposed on the fork and safetied with a cotter pin
e. This is an AN corrosion-resistant steel bolt

ANSWERS TO THEORY TEST

- f. Bolt grip lengths should be equal to the thickness of the material through which they extend
 - g. A class 3 fit
 - h. 1 1/4"
 - i. Only for shear load applications
 - j. Coarse, fine
 - k. 1/16
 - l. 1/8
 - m. 3/16, 1/4
 - n. Internal wrenching
7. a. 4
b. 3
c. 1) AN standard steel bolts
2) Aluminum alloy bolt
3) Magnetically inspected bolt
4) Special bolt
d. 1) Standard hex head
2) Eyebolt
3) Internal hex head
8. a. Self-locking low-temperature
b. Self-locking high-temperature
c. Castle nut
d. Plain nut
e. Check nut
f. Shear castle nut
9. a. 3
b. 4
c. 2
10. a. Large area washer
b. Plain washer
c. Split lock washer
d. Shakeproof washer
e. High strength countersunk washer
11. a. Split lock
Usage - Used where a joint is not critical and a self-locking or castellated nut is not appropriate
b. Large area washer
Usage - Used on wooden structures to spread the load of the fastener over a wider area
c. Plain washer
Usage - Used between nut and material being clamped
d. Shakeproof washer
Usage - Used in high vibration and high heat areas

ANSWERS TO THEORY TEST

12.
 - a. Machine screws
 - b. Structural screws
 - c. Self-tapping screws
13.
 - a. Clevis
 - b. Roll
 - c. Taper
 - d. Cotter
14.
 - a. Non-structural
 - b. Class 2 fit
 - c. AN 509 has a cross on its head indicating that it is made of high-strength steel
 - d.
 - 1) Round head
 - 2) Truss head
 - 3) Countersunk head
 - 4) Countersunk oval head
 - e. The roll pin is made of spring steel and when it is pressed into the hole, the spring action holds it tight against the edge of the hole
 - f. A cotter pin
 - g. The short leg
15.
 - a. To restore damaged threads
 - b. To provide wear-resisting threads in soft castings
16.
 - a. Dzus
 - b. Camlock
 - c. Airlock
17.
 - a. Used on cowlings and the many inspection access doors that must be opened frequently
 - b. The slots in the fasteners will be lined up
 - c. There will not be a positive locking action when locking the fastener, or the fastener will be loose
18.
 - a. The dimensional change of the aircraft caused by temperature variation will affect the tension of the cable unless automatic tensioners are installed
 - b.
 - 1) Galvanized carbon steel
 - 2) Stainless steel
 - c. 133
 - d. 100 percent
19. Performance skills evaluated to the satisfaction of the instructor

ANSWERS TO THEORY TEST

- 20. a. No more than three threads
b. The end of the turnbuckle with the groove has left-hand threads
- 21. a. Three
b. Double-wrap method
- 22. Performance skills evaluated to the satisfaction of the instructor
- 23. Performance skills evaluated to the satisfaction of the instructor

MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G104 TECHNICAL MECHANICS
FABRICATE AND INSTALL RIGID AND FLEXIBLE
FLUID LINES AND FITTINGS
G104-D

GENERAL
G104 TECHNICAL MECHANICS
FABRICATE AND INSTALL RIGID AND FLEXIBLE
FLUID LINES AND FITTINGS
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- B. Specific Objectives
- C. Instructor's Module Implementation Guide
 - 1. Instructional Supplement #1--Tube Bending
- D. Technical Information Supplement #1--Terms and Definitions
- E. Transparency Masters
 - 1. TM #1--Identification of Metallic Materials
 - 2. TM #2--Rigid Tubing Size Designations
 - 3. TM #3--Correct and Incorrect Tubing Bends
 - 4. TM #4--Flare Dimensions
 - 5. TM #5--Flare Nuts
 - 6. TM #6--Cutaway View of Single- and Double-Flared Tube Ends
 - 7. TM #7--Presetting Flareless Tube Assembly
 - 8. TM #8--Flareless Fitting Features
 - 9. TM #9--Beaded Tube Dimensions
 - 10. TM #10--AN and AC Fitting to Flexible Hose
 - 11. TM #11--Flexible Hose Assemblies
 - 12. TM #12--Assembly of MS Fitting to Flexible Hose
 - 13. TM #13--Flexible Hose Installations
 - 14. TM #14--Flexible Hose Installations (Continued)
 - 15. TM #15--Flexible Hose Installations (Continued)
 - 16. TM #16--Flexible Hose Installations (Continued)

MODULE CONTENTS

- 17. TM #17--Tightening Flared Fittings
- 18. TM #18--Repair to a Rigid Fluid Line
- F. Project Guides
 - 1. Project Guide #1--Perform Tube Flaring
 - 2. Project Guide #2--Perform Tube Bending
 - 3. Project Guide #3--Perform Tube Beading
 - 4. Project Guide #4--Fabricate Flareless Fitting Tube Assemblies
 - 5. Project Guide #5--Fabricate a Double Flare
 - 6. Project Guide #6--Fabricate Flexible Hose Assembly
 - 7. Project Guide #7--Install Rigid and Flexible Fluid Lines
- G. Theory Test
- H. Answers to Theory Test
- I. Practical Test #1--Fabricate and Install Rigid and Flexible Fluid Lines and Fittings

GENERAL
G104 TECHNICAL MECHANICS
FABRICATE AND INSTALL RIGID AND FLEXIBLE
FLUID LINES AND FITTINGS
G104-D

INTRODUCTION

As aircraft become more versatile and more effective, they also become more sophisticated. Many of today's airplanes have hydraulic landing gear that require thousands of pounds of force to retract. They have boosted flight controls requiring hydraulic fluid under high pressure to be carried throughout the aircraft, and the fuel systems through which the huge quantities of fuel flow to the engines are built of complex lines, valves, and fittings.

The plumbing used to carry the vital fluids must be strong, as some of the fluids are under normal pressure of up to 3,000 psi and have transient pressure surges rising far above this. These lines must be light in weight and must use fittings that produce a minimum drop in the pressure of the fluid flowing through them. Provisions must be made, by the use of flexible hose, for relative motion between the airframe and such shock-mounted components as the engines and the instrument panels.

MODULE OBJECTIVE

After completion of this module, you will be able to explain the construction and usage of low-, medium-, and high-pressure hose, identify flareless fittings, and distinguish between correct and incorrect flexible hose installations. You will also be able to perform tube flaring, bending and beading, fabricate flexible hose assemblies and install rigid and flexible fluid lines. You will further demonstrate this knowledge by scoring 85 percent on the module theory test and by meeting airworthiness standards on the module practical test.

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SPECIFIC OBJECTIVES

After completion of this module, you will be able to:

- | | |
|--|--|
| 1. Match terms and definitions related to rigid and flexible fluid lines and fittings. (1) | Technical Supplement #1 |
| 2. Select statements related to materials and size designations of rigid tubing. | EA-ITP-G 4:III:55-56
AC-65-9A 5:99-100 |
| 3. Select statements related to the fabrication of rigid tubing assemblies. (1) | EA-ITP-G 4:III:56-64
AC-65-9 55:111-113 |
| 4. Perform tube flaring. (3) | Project Guide #1 |
| 5. Perform tube bending. (3) | Project Guide #2 |
| 6. Perform tube beading. (3) | Project Guide #3 |
| 7. Fabricate flareless fitting tube assemblies. (3) | Project Guide #4 |
| 8. Fabricate a double flare. (3) | Project Guide #5 |
| 9. State facts related to flexible hose construction. (1) | EA-ITP-G 4:III:64-65 |
| 10. Select statements related to measurement and identification of flexible fluid lines. (1) | EA-ITP-G 4:III:65 |
| 11. Distinguish between the characteristics of low-, medium-, and high-pressure hose. (2) | EA-ITP-G 4:III:66-67 |
| 12. Select statements related to the construction, usage, and advantages of Teflon hose. (1) | EA-ITP-G 4:III:67 |
| 13. State facts related to methods used for attaching fluid line fittings to components. (1) | EA-ITP-G 4:III:67-69
EA-ITP-CW 4:39-40 |

SPECIFIC OBJECTIVES

- | | | |
|--|-----------------------|--------------------------|
| 14. State facts related to flared fittings used to connect rigid fluid lines. (1) | EA-ITP-G | 4:III:69-70 |
| 15. Identify typical flareless fittings. (2) | EA-ITP-G | 4:III:69-70 |
| 16. Select statements related to fittings for flexible hose. (1) | EA-ITP-G | 4:III:71-75 |
| 17. Fabricate flexible hose assemblies. (3) | Project Guide #6 | |
| 18. Select statements related to the routing, securing, servicing, and identification marking used in fluid line installation. (1) | EA-ITP-G
AC-65-9A | 4:III:75-78
5:118-119 |
| 19. Distinguish between correct and incorrect flexible hose and rigid tubing installations. (2) | EA-ITP-G | 4:III:76 |
| 20. Match color codes or names to the related fluid line code symbols. (1) | EA-ITP-G
EA-ITP-GW | 4:III:77
4:41-42 |
| 21. Install rigid and flexible fluid lines. (3) | Project Guide #7 | |

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INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module--Booklet:

Parker Hannifin Booklet: Bulletin 4306.B5
"Principles of Tube Line Fabrication."

(NOTE: This is available from Tube Fittings Division, 17325 Euclid Avenue, Cleveland, Ohio 44112.)

II. Implementation Suggestions

Estimated Teaching Time		Theory	Lab
Objective 1	Explain the terms and definitions. Have students review Technical Information Supplement #1.		
Objective 2	Explain types of materials and size designations used for rigid tubing. Use Transparency Masters #1 and #2.		
Objective 3	Explain the fabrication processes used on rigid tubing assemblies. Use Transparency Masters #3 - #9.		
Objective 4	Discuss Project Guide #1. Demonstrate tube flaring. Have students complete Project Guide #1.		
Objective 5	Discuss Project Guide #2. Demonstrate tube bending. Provide students with booklet "Principles of Tube Line Fabrication" and with copies of Instructional Supplement #1. Have students complete Project Guide #2.		
Objective 6	Discuss Project Guide #3. Demonstrate tube beading. Have students complete Project Guide #3.		
Objective 7	Discuss Project Guide #4. Demonstrate fabrication of flareless fitting tube assemblies. Have students complete Project Guide #4.		

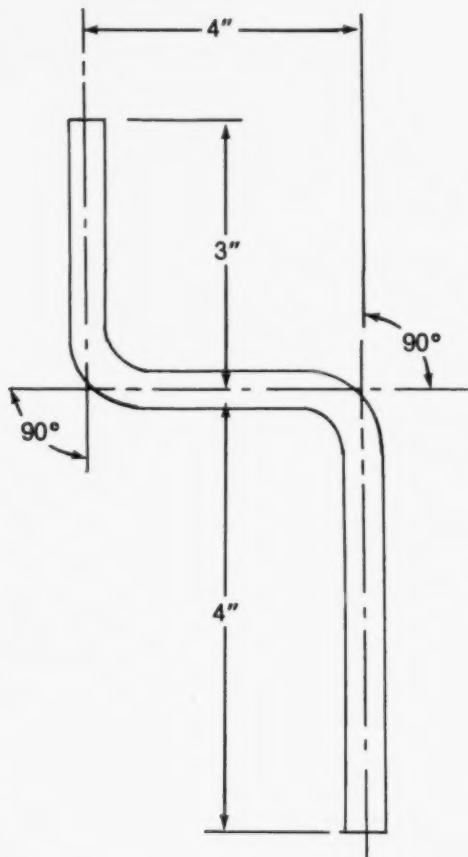
INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 8	Discuss Project Guide #5. Demonstrate how to fabricate a double flare. Have students complete Project Guide #5.		
Objective 9	Explain details related to flexible hose construction.		
Objective 10	Explain how flexible fluid lines are measured and identified.		
Objective 11	Explain the characteristics of low-, medium-, and high-pressure hose. Include their construction and uses.		
Objective 12	Explain the construction, usage, and advantage of Teflon hose.		
Objective 13	Explain methods used for attaching fluid line fittings to components. Have students complete EA-ITP-GW #4, pages 39-40.		
Objective 14	Explain flared fittings. Use Transparency Master #10.		
Objective 15	Identify typical flareless fittings. Show students examples of each type.		
Objective 16	Explain fittings used for flexible hoses. Use Transparency Masters #11 and #12.		
Objective 17	Discuss Project Guide #6. Demonstrate fabrication of flexible hose assembly. Have students complete Project Guide #6.		
Objective 18	Explain the routing, securing, servicing, and identification marking used in fluid line installations.		
Objective 19	Explain correct and incorrect flexible hose and rigid tubing installations. Use Transparency Masters #13 - #18.		
Objective 20	Explain colors, symbols, and names used to code fluid lines. Have student complete EA-ITP-GW 4, pages 41-42.		
Objective 21	Discuss Project Guide #7. Demonstrate installation of rigid and flexible fluid lines. Have students complete Project Guide #7.		

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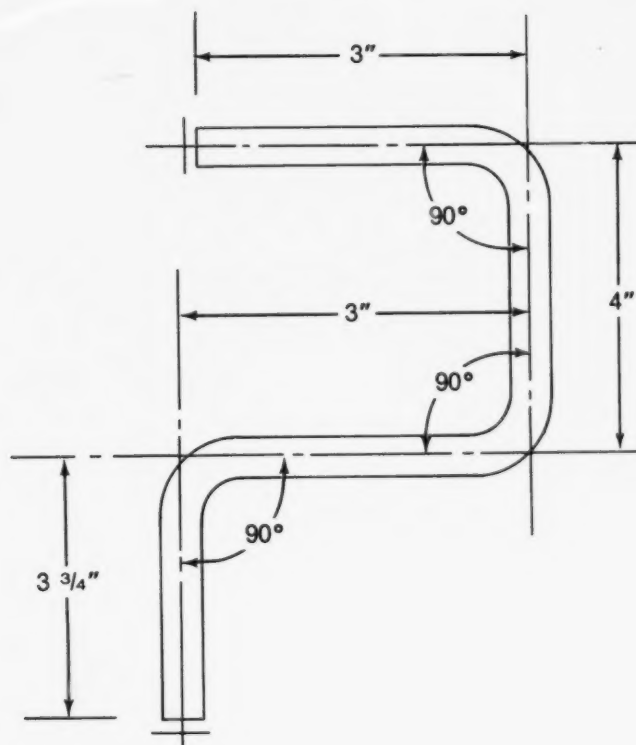
INSTRUCTIONAL SUPPLEMENT #1--Tube Bending

FIGURE A



INSTRUCTIONAL SUPPLEMENT #1

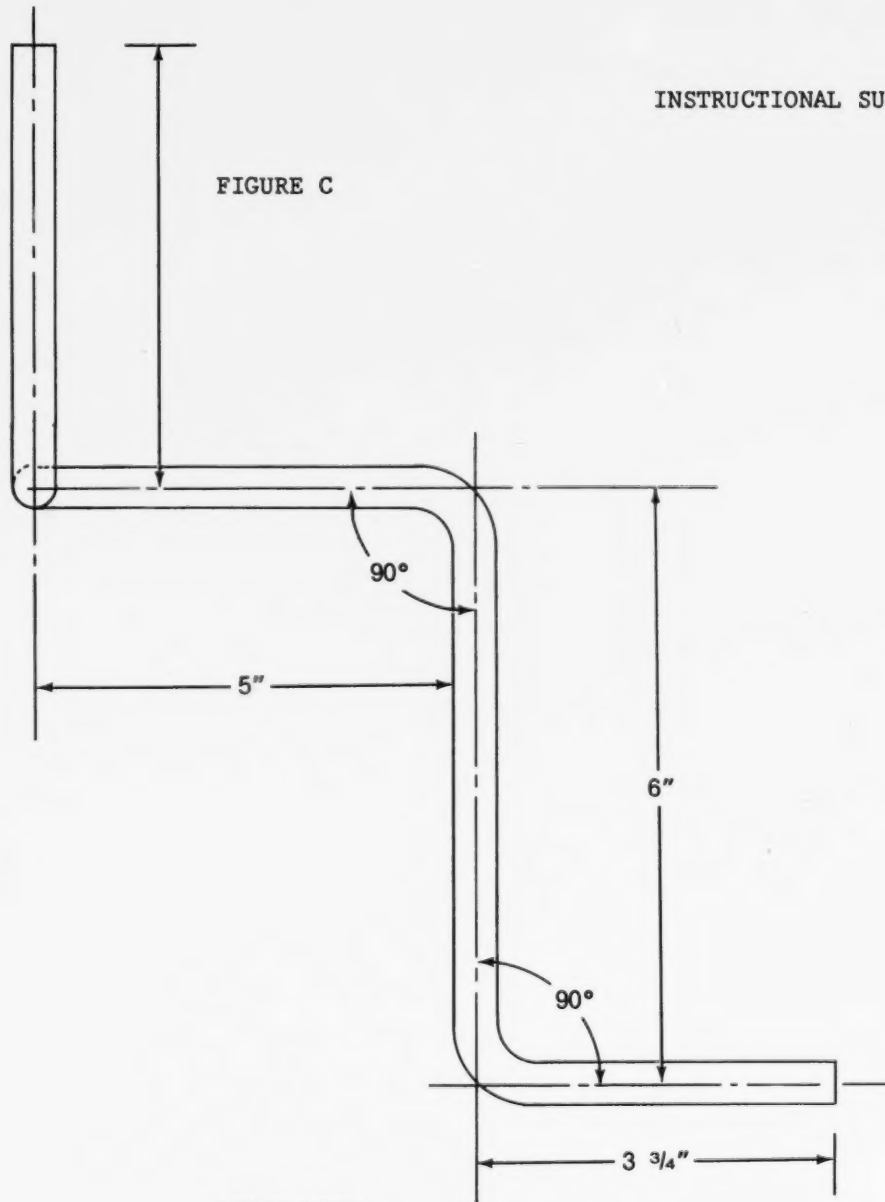
FIGURE B



INSTRUCTIONAL SUPPLEMENT #1

FIGURE C

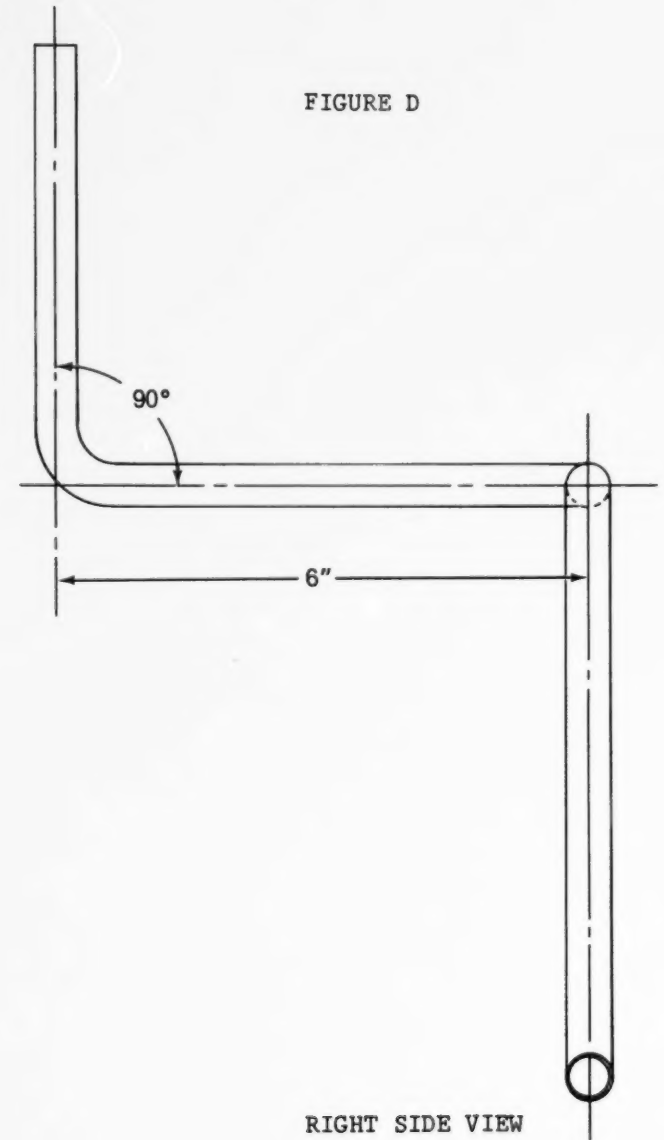
G104D-13



FRONT VIEW

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FIGURE D



RIGHT SIDE VIEW

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TECHNICAL INFORMATION SUPPLEMENT #1--Terms and Definitions

- A. Aircraft plumbing--Hoses, tubing, fittings, and connectors used for carrying fluids through an aircraft
- B. Hydraulics--Branch of science that deals with the transmission of power by incompressible fluids under pressure
- C. Boosted flight controls (boost system)--Hydraulically actuated system which aids the pilot in operation of the controls
- D. Valve--Numerous devices by which the flow of liquid or gas may be started, stopped, or regulated by a moveable part that opens, shuts, or partially obstructs one or more parts or passageways; the movable part of such a device
- E. Fitting--Part used to join or attach assemblies together
- F. Crystallize--To cause to form crystals or assume crystalline form
- G. Alloy--Substance of different elements, one of which is a metal
- H. Wall thickness--Thickness of the material used to form rigid tubing, measured in thousandths of an inch

(NOTE: To find the inside diameter of a tube, subtract twice the wall thickness from the outside diameter.)
- I. Polymerization--Process of joining two or more chemicals with molecules of similar structure, forming a more complex molecule with different physical properties

(NOTE: In this chemical reaction, the material essentially gels.)
- J. Mandrel--Metal device that serves as a core around which material may be cast, molded, forged, bent, or otherwise shaped
- K. Radius block--Metal block around which sheet metal is bent to obtain a specific bend radius
- L. Flareless fitting--Form of fluid line fitting used on some hydraulic brake lines in which a sleeve is forced into the tube to form the sealing surface
- M. Tube bead--Bulge at the end of a tube used in conjunction with flexible hose and hose clamps

TECHNICAL INFORMATION SUPPLEMENT #1

- N. Relative movement--Movement of one object with relation to another
- O. Neoprene--Oil-resistant synthetic rubber made by polymerizing chloroprene
(NOTE: Neoprene is used in seals and locknuts.)
- P. Buna-N--One of several rubbers made by polymerization or copolymerization of butadiene
- Q. Butyl--Trade name of a synthetic rubber product made by the polymerization of isobutylene
(NOTE: Butyl withstands such potent chemicals as Skydrol hydraulic fluid.)
- R. Teflon--Proprietary name for a fluorocarbon resin used to make hydraulic and pneumatic seals, and backup rings
- S. Abrasion--Roughening or wearing away of a surface by scratches or marks usually caused by foreign matter between moving parts or surfaces
- T. Lay line--Yellow, red, or white stripe running the length of a flexible hose
(NOTE: The line serves to identify the hose and to indicate whether or not the line was twisted when installed.)
- U. Skydrol hydraulic fluid--Synthetic, nonflammable, ester-base hydraulic fluid used in modern high-temperature hydraulic systems
(CAUTION: Do not spill on skin.)
- V. Burr--Sharp or rough projection of metal usually resulting from machine processing

Identification of Metallic Materials

Material	Magnet Test	Nitric Acid Test
Carbon Steel .	Strongly Magnetic	Slow Chemical Action, Brown
18-8	Nonmagnetic	No Action
Pure Nickel . . .	Strongly Magnetic	Slow Action Pale Green
Monel	Slightly Magnetic	Rapid Action Greenish Blue
Nickel Steel . .	Nonmagnetic	Rapid Action Greenish Blue

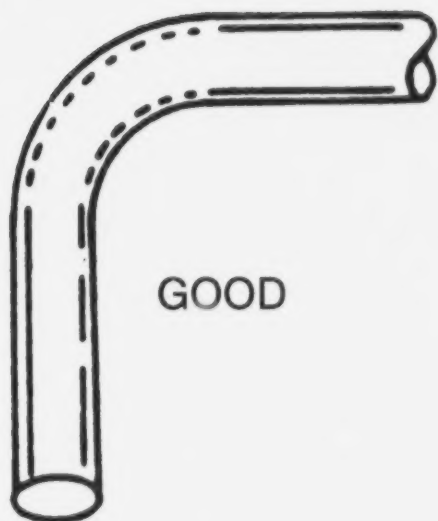
Rigid Tubing Size Designations

Tube O.D.	Fittings Dash No.
$\frac{1}{8}$	- 2
$\frac{1}{4}$	- 4
$\frac{3}{8}$	- 6
$\frac{1}{2}$	- 8
$\frac{5}{8}$	-10
$\frac{3}{4}$	-12
1	-16

The outside diameter of rigid tubing is identified by its dash number. The dash number is the numerator of the fractional diameter in sixteenths of an inch.

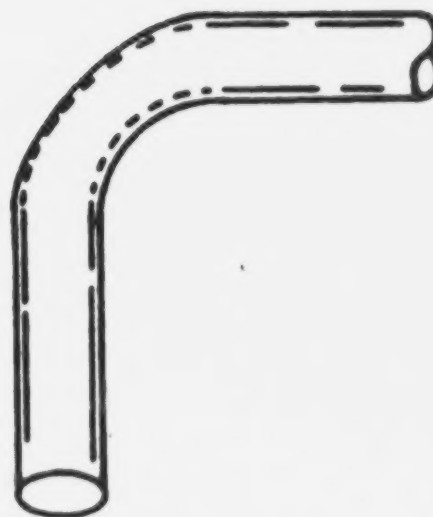
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Correct and Incorrect Tubing Bends

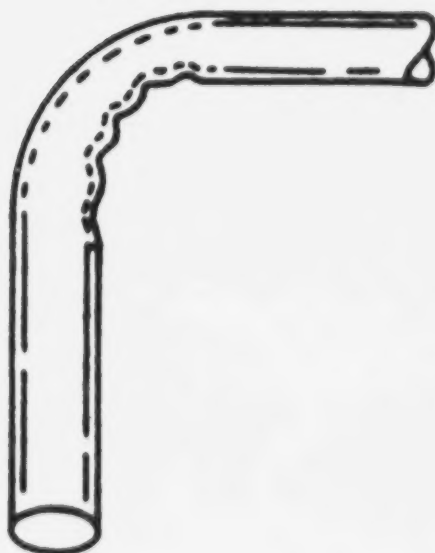


GOOD

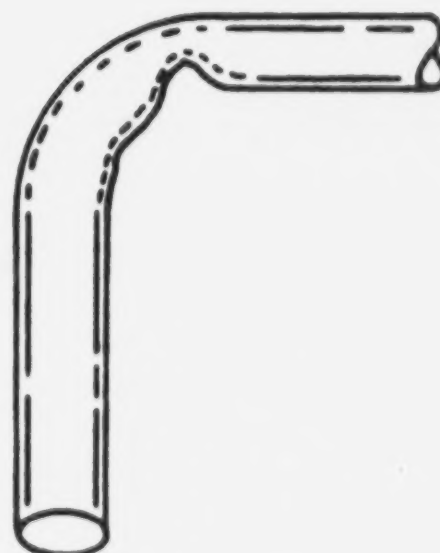
Perfect Bend



Flattened Bend

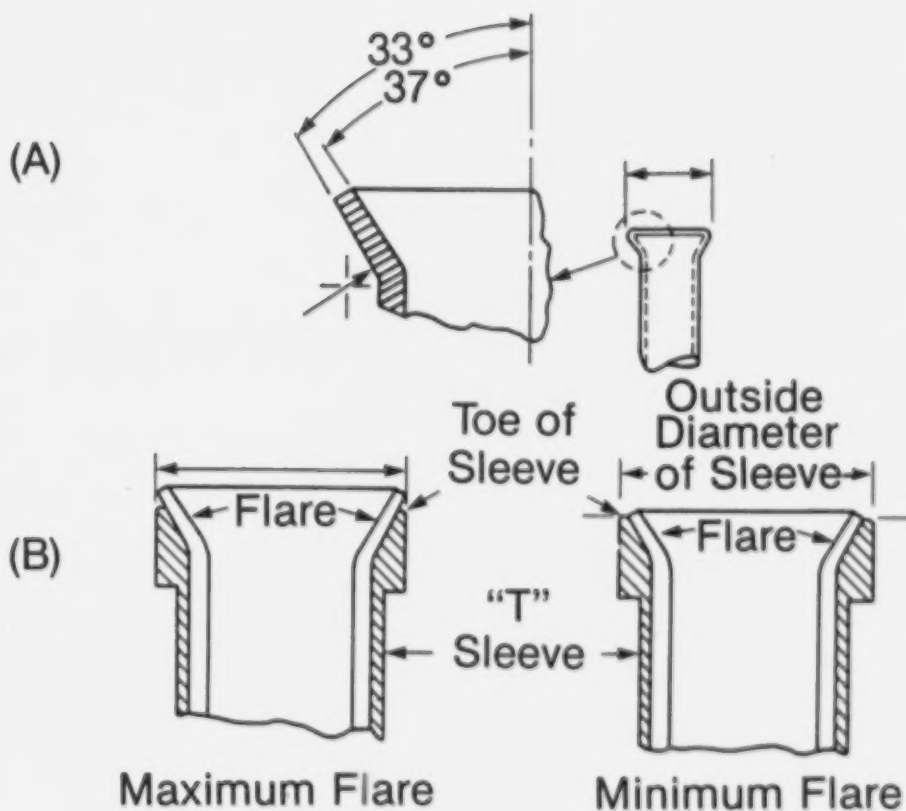


Wrinkled Bend



Kinked Bend

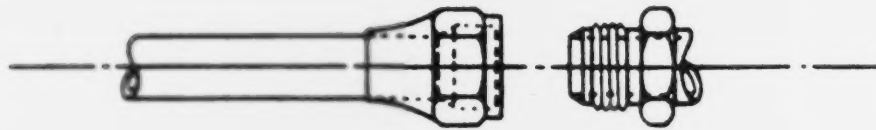
Flare Dimensions



A — Aircraft rigid tubing is flared with a flare angle of 37°. B — The tube must be flared so the outside diameter of the flare is at least the diameter of the toe of the sleeve, but is no larger than the outside diameter of the sleeve.

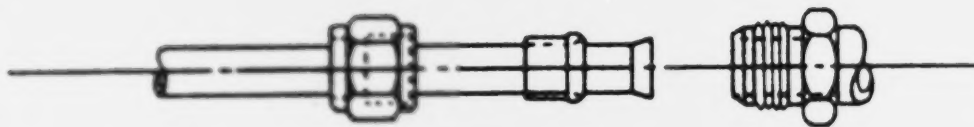
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Flare Nuts



AN817 Nut

(A)



AN818 Nut

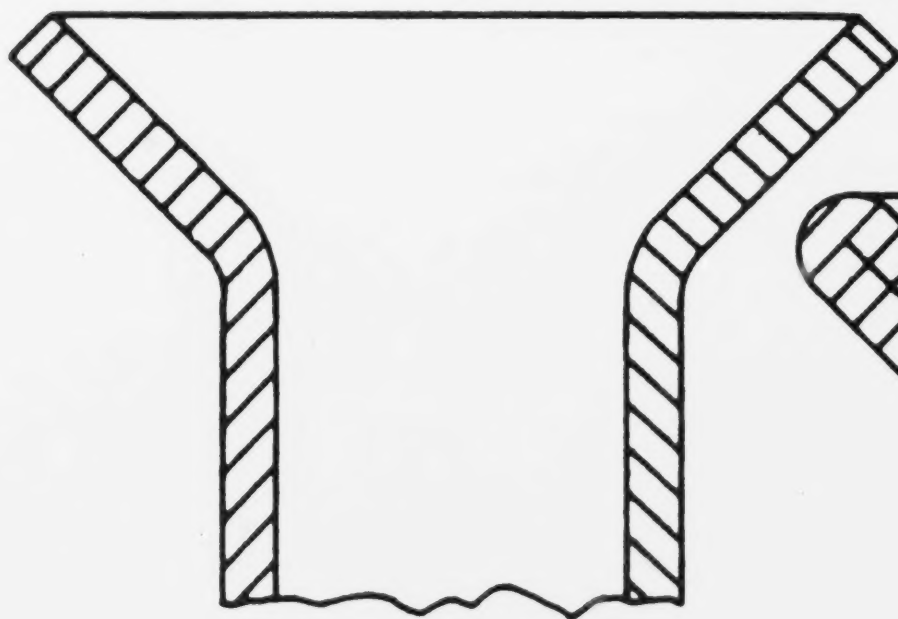
MS20819
Sleeve

(B)

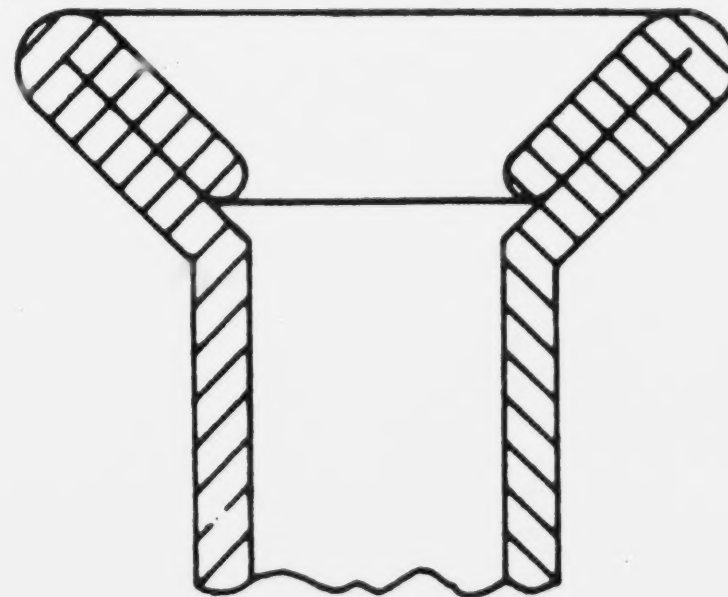
A — The AN817 nut is a single-piece nut and can be used only when there are no bends near the end of the tubing. These nuts are not as satisfactory as the nut and sleeve combination, as they tend to wipe, or iron, the flare as it is being tightened. B — The AN818 nut with the MS20819 sleeve is the most popular type of nut found on rigid tubing. These nuts are commonly called B-nuts.

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Cutaway View of Single- and Double-Flared Tube Ends



A. Single-Flared End



B. Double-Flared End

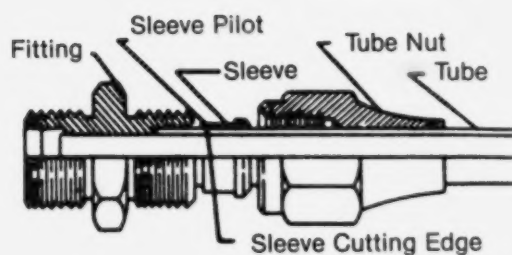
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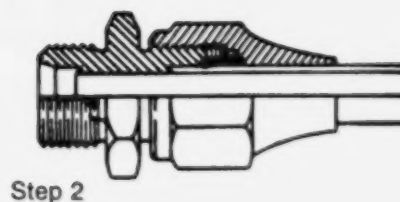
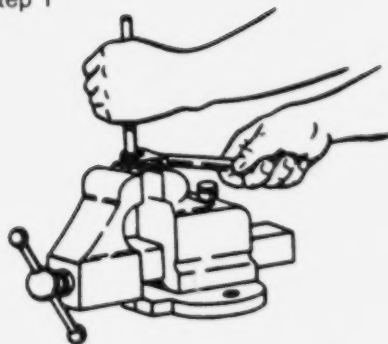
TM #6

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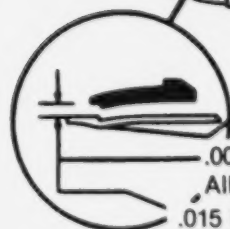
Presetting Flareless Tube Assembly



Step 1



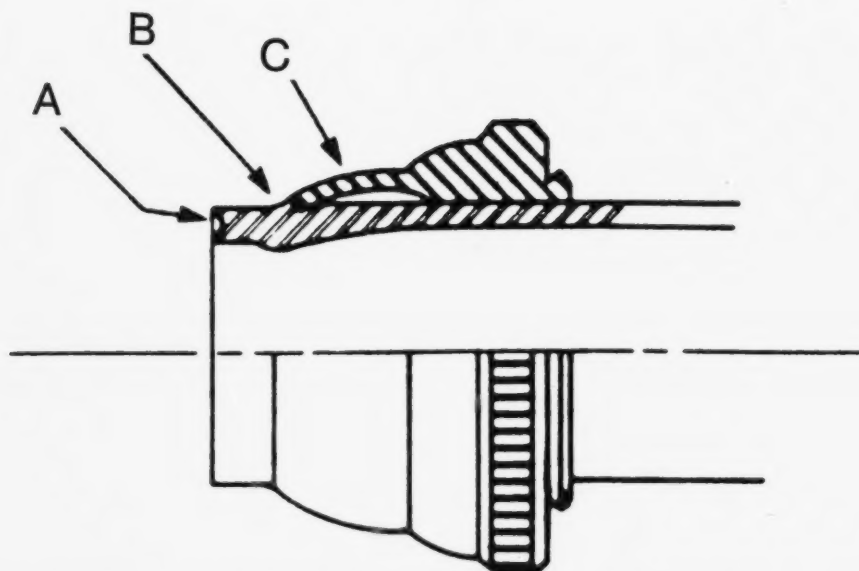
$\frac{3}{32}$ to
 $\frac{1}{8}$ Inch



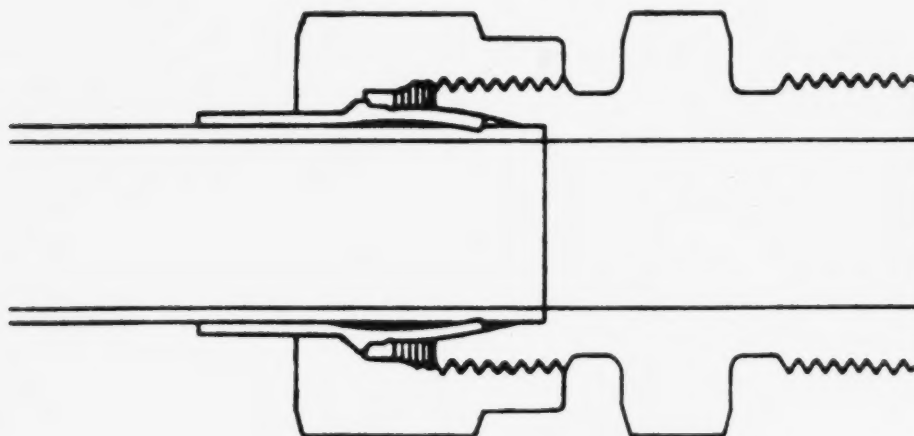
Step 3

Slight Deformation Permissible
.005 Inch Maximum — Aluminum
Alloy Tubing
.015 Inch Maximum — Corrosion-
Resistant Steel Tubing

Flareless Fitting Features



The end of the tube should have a uniform indentation all around its end (A), the bite of the tube should raise material approximately one-half of the thickness of the ferrule leading edge (B), and the ferrule should be slightly bowed (C).

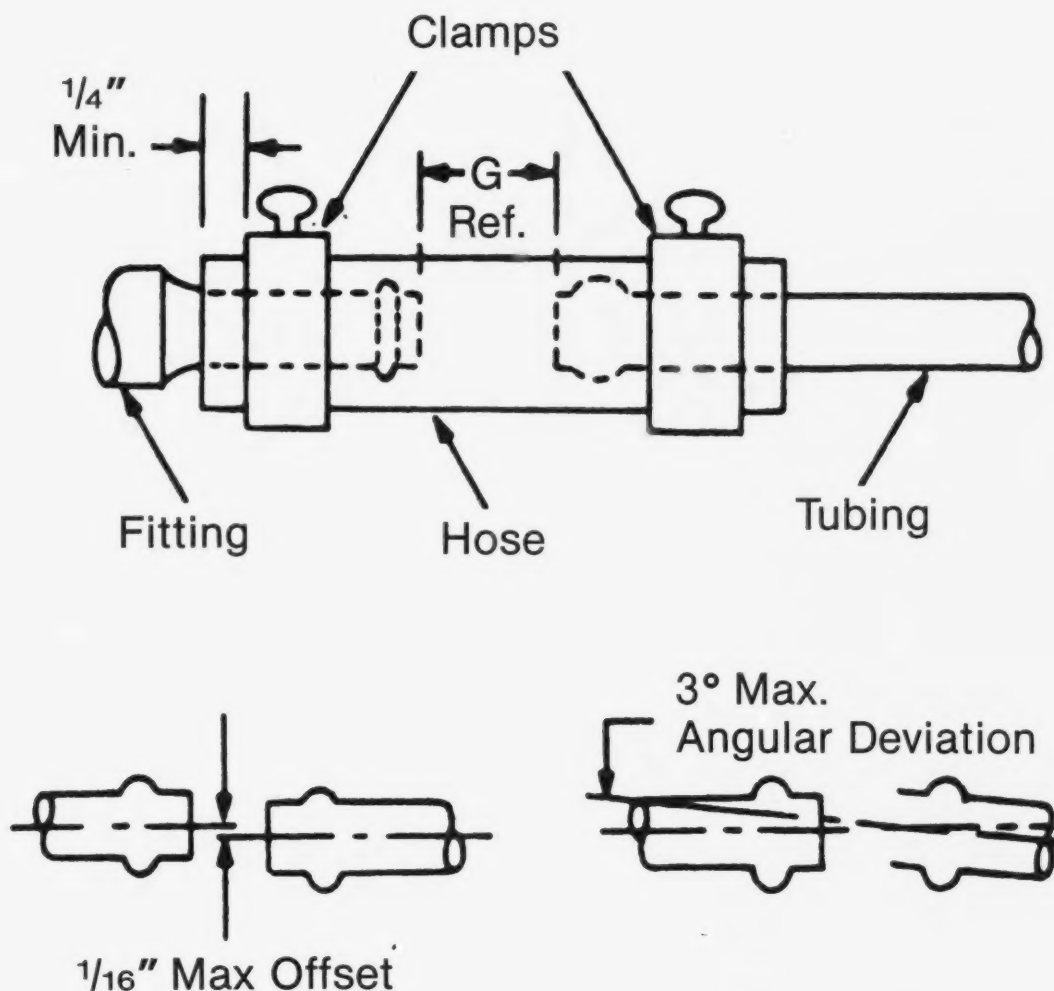


A properly connected flareless tube fitting

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TM #8

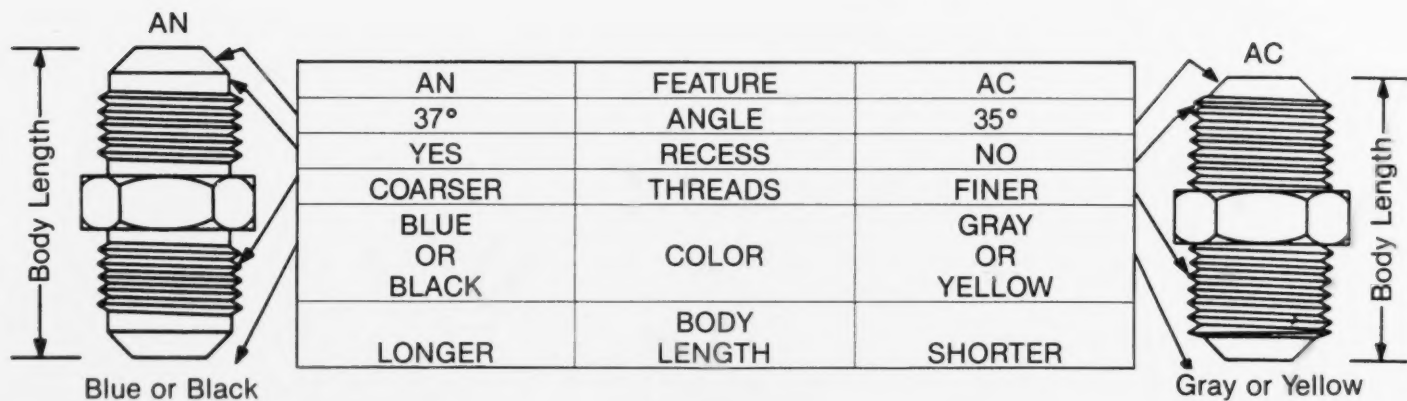
Beaded Tube Dimensions



Minimum gap "G" shall be $\frac{1}{2}"$ or Tube OD/4, whichever is greater
 Maximum gap "G" is not limited except on suction lines using other than self-sealing hose. On such suction lines, maximum G shall be $1\frac{1}{2}$ inch or one tube diameter, whichever is greater.

Flexible Fluid Connection Assembly

AN and AC Fitting to Flexible Hose



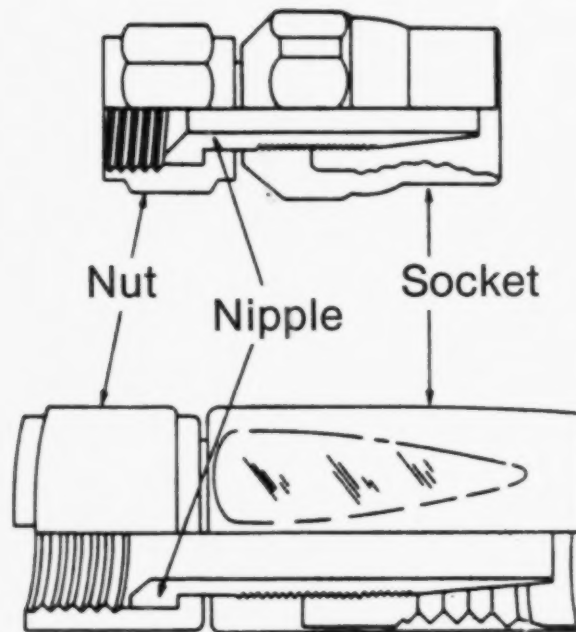
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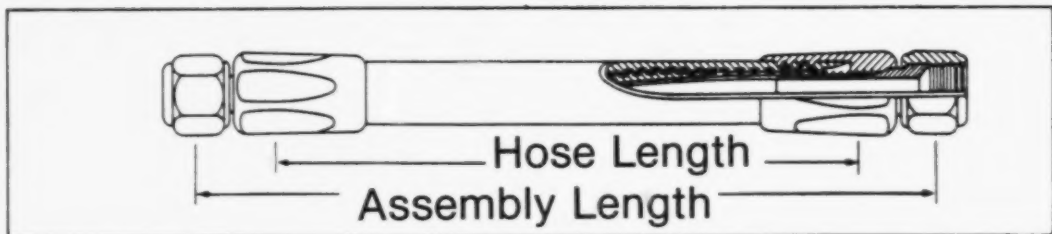
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TM #10

Flexible Hose Assemblies



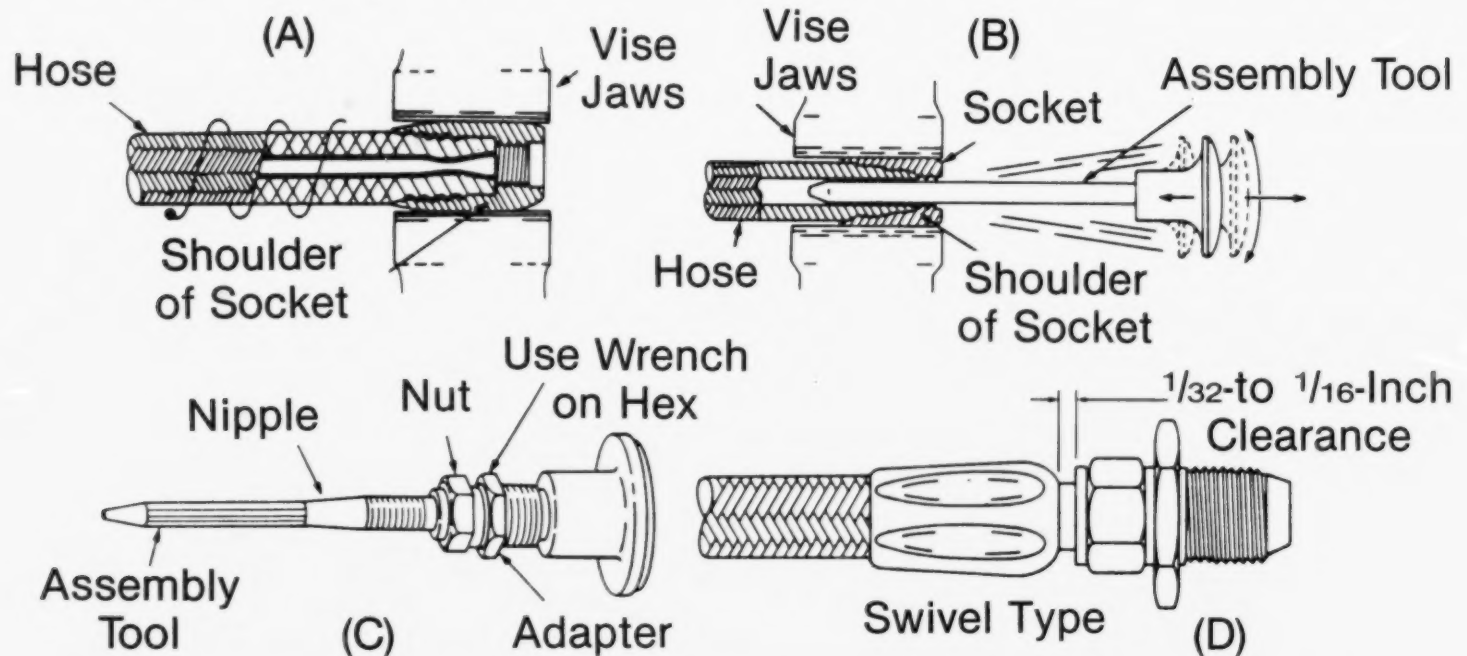
Sleeve-Type Fittings



The length required for a hose is the distance between the fittings, plus the required 5% to 8% of this length for slack, minus twice the distance between the end of the nipple and the end of the hole in the socket.

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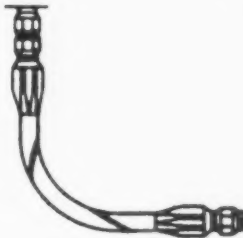
Assembly of MS Fitting to Flexible Hose



A — Screw the end of the hose into the left-hand threads of the socket. Leave a small amount of clearance between the end of the hose and the end of the hole in the socket. B — Lubricate the assembly tool and work it into the end of the hose to open out the end and force the tube tight into the socket. C — Screw the nipple and nut onto the assembly tool and force the nipple into the socket. Screw the nut down tight against the socket. D — Back the nut off about $\frac{1}{32}$ to $\frac{1}{16}$ inch and remove the assembly tool from the tube.

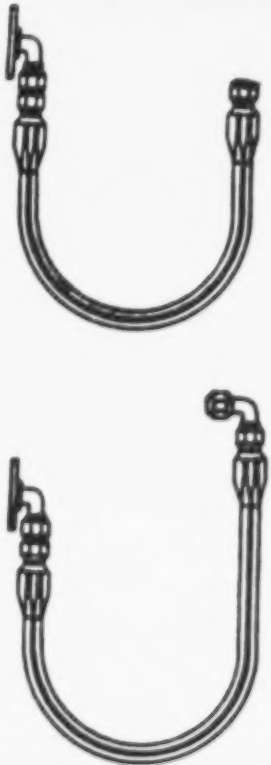
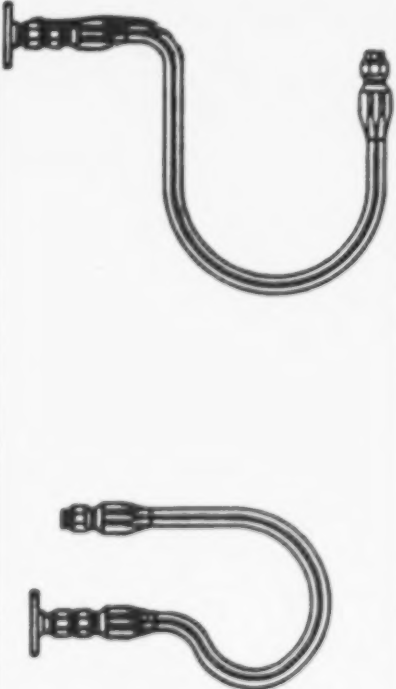
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Flexible Hose Installations

RIGHT WAY	WRONG WAY	
 	 	Do not bend or twist the hose as illustrated. Allow enough slack in the hose line to provide for changes in length when pressure is applied. The hose will change in length from +2% to -4%. Metal end fittings cannot be considered as part of the flexible portion of the assembly.

Flexible Hose Installations

(Continued)

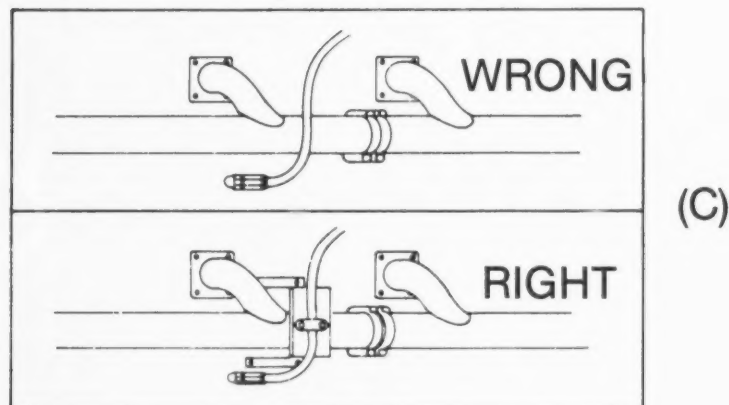
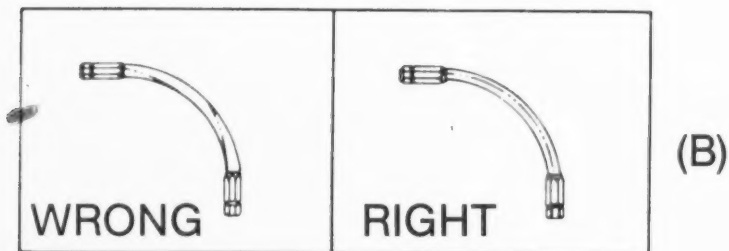
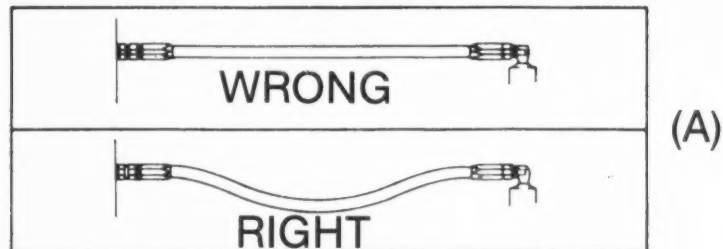
RIGHT WAY	WRONG WAY	The use of elbows and adapters will assure easier installation and in many installations will remove the strain from the hose line and greatly increase service life. At all times keep the minimum bend radii of the hose as large as possible to avoid tube collapsing.
		

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TM #14

Flexible hose Installations

(Continued)

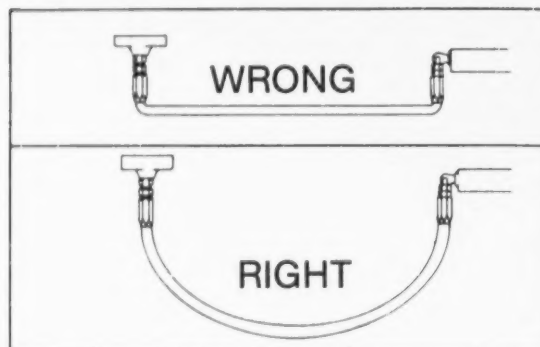


A — A flexible hose must not be stretched tight between two fittings. It must have between five and eight percent slack. B — The lay line must run straight along the hose, indicating that the hose was not twisted when it was installed. C — When a flexible line is routed near a hot exhaust manifold it must be secured to the aircraft structure so that it cannot touch the hot metal.

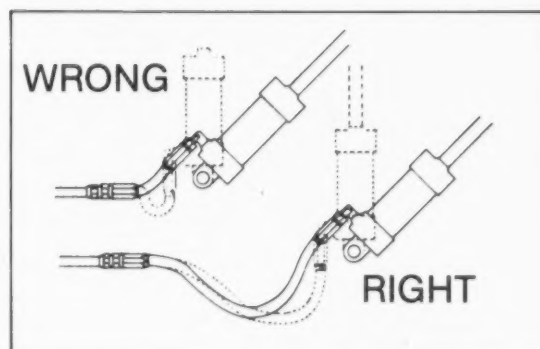
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Flexible Hose Installations

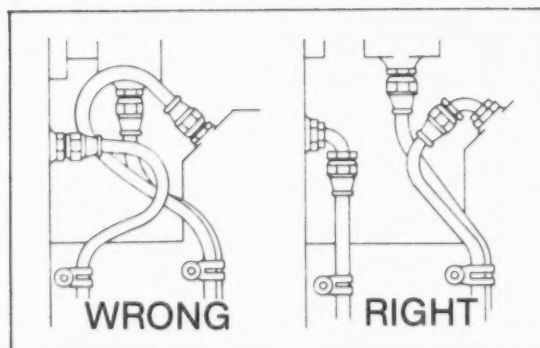
(Continued)



(D)



(E)



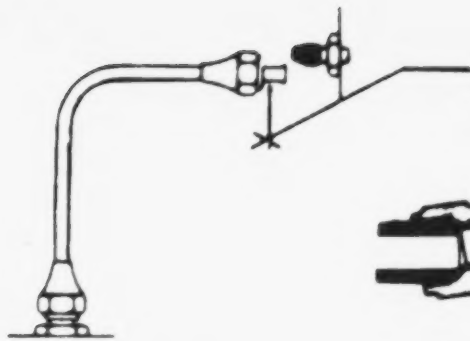
(F)

D — Be sure to observe the minimum bend radius when installing hose. It would have been better to use a 90° elbow for one of these fittings. E — Be sure to allow sufficient slack when attaching a hose to a movable cylinder. F — Always use the proper fittings to prevent unwieldy lengths of hose.

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TM #16

Tightening Flared Fittings



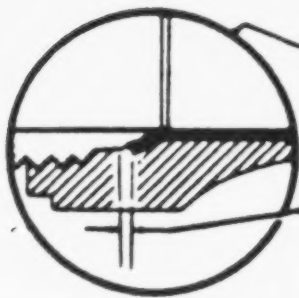
Do not Deflect into Place
Replace Tube Assembly



Incorrect — Will
Damage Flare or
Threads, or Cause
Sleeve to Crack Under
Vibration if Tightened



Incorrect — May Pull
Off or Distort Flare if
Tightened



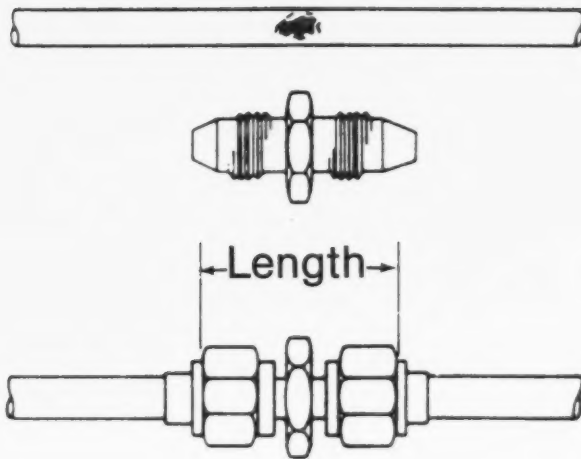
Correctly Fitted
and Tightened

.025 Clearance Between
Flare and Shoulder
Before Tightening

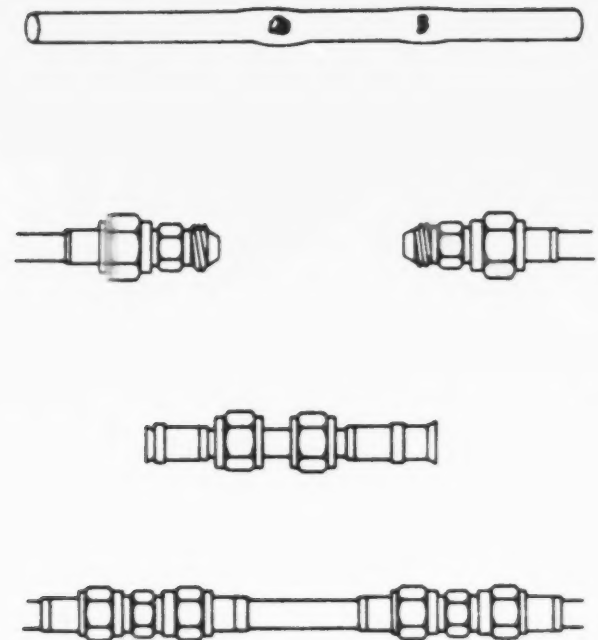
**Correct and Incorrect Methods of
Tightening Flared Fittings.**

Repair To a Rigid Fluid Line

(A)



(B)



A — Repair to a high-pressure rigid fluid line by using a union and two nuts. B — Repair to a high-pressure fluid line by splicing in a new section of line.

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TM #18

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PROJECT GUIDE #1--Perform Tube Flaring

PURPOSE: To allow the student to develop skill in tube flaring and in using hand flaring tools.

REFERENCE MANUALS: None

EQUIPMENT AND TOOLS NEEDED:

- A. Tubing cutter
- B. Tube flaring tool
- C. One-inch micrometer
- D. Tube pressure tester
- E. 3/4-inch open-end wrench
- F. Deburring tool

SUPPLIES AND MATERIALS:

- A. One piece of aluminum tubing--3/8-inch gauge, 14 inches long
- B. Grease
- C. One sheet of 500-grit wet or dry sandpaper
- D. Two B-nuts (AN818-6) and sleeves (AN819-6)

PROCEDURE:

- A. Prepare one end of the tube for flaring by removing all nicks, burrs, and scratches with the deburring tool on the tubing cutter and with the 500-grit sandpaper (See Figures 1 and 2 on next page)

(NOTE: Be sure to remove the ridge of metal which forms inside the tube as a by-product of the cutting procedure.)

FIGURE 1

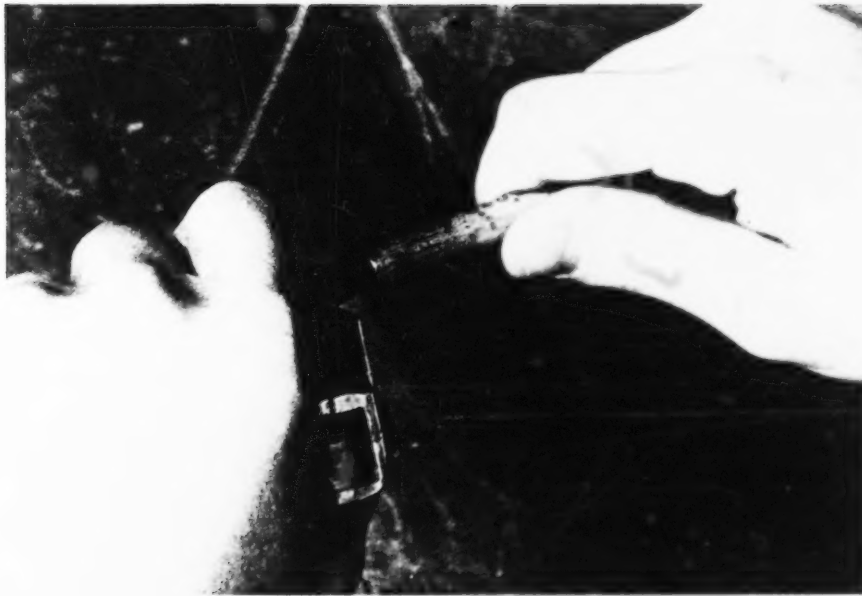
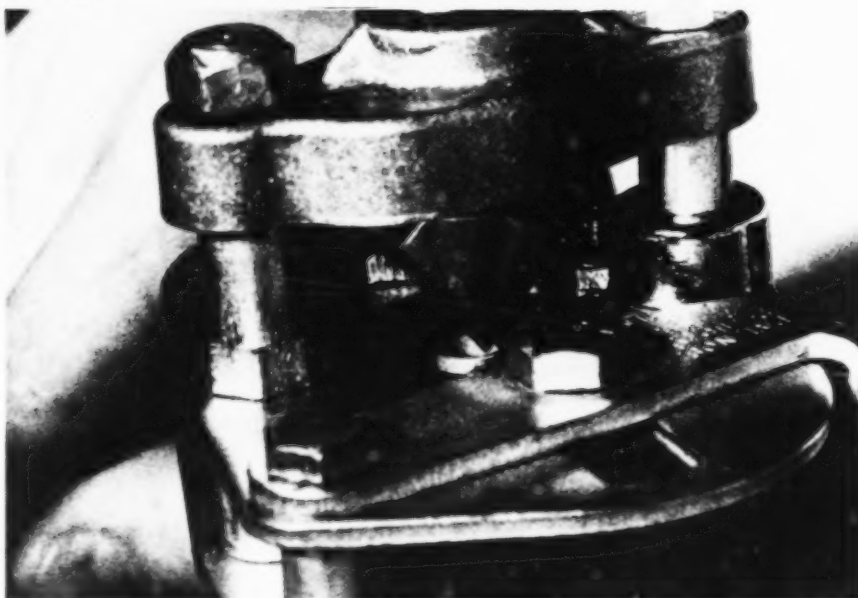


FIGURE 2



- B. Insert the tube in the block of the flaring tool from underneath, making sure that the tube end to be flared is flush with the upper surface of the flaring tool (Figure 3)

FIGURE 3



- C. Clamp the tube securely in the block (Figure 4)

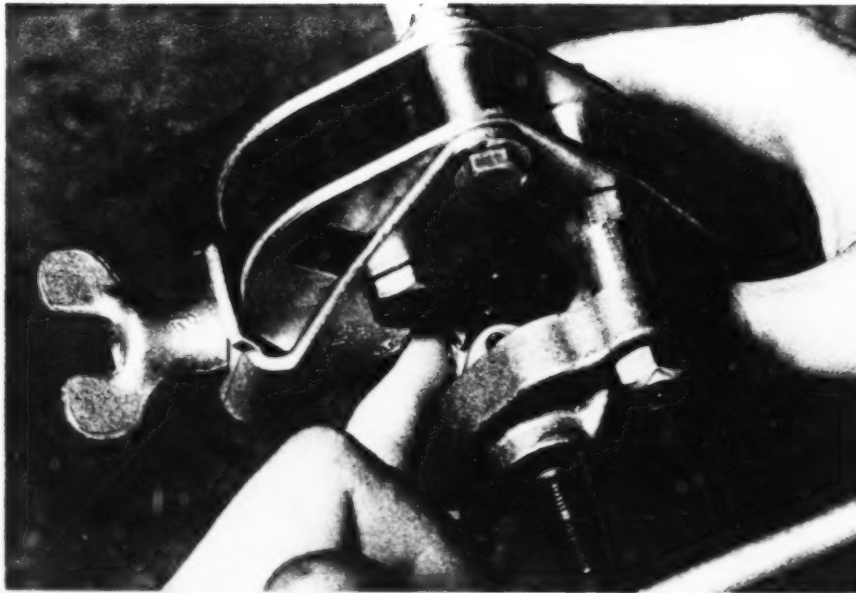
(NOTE: Be careful not to distort the tube by clamping too tightly.)

FIGURE 4



- D. Lubricate the cone of the flaring tool with a small amount of grease (Figure 5)

FIGURE 5



- E. Center the flaring cone in the tube (Figure 6)

FIGURE 6



- F. Turn the handle of the cone clockwise to begin to form the flare (Figure 7)

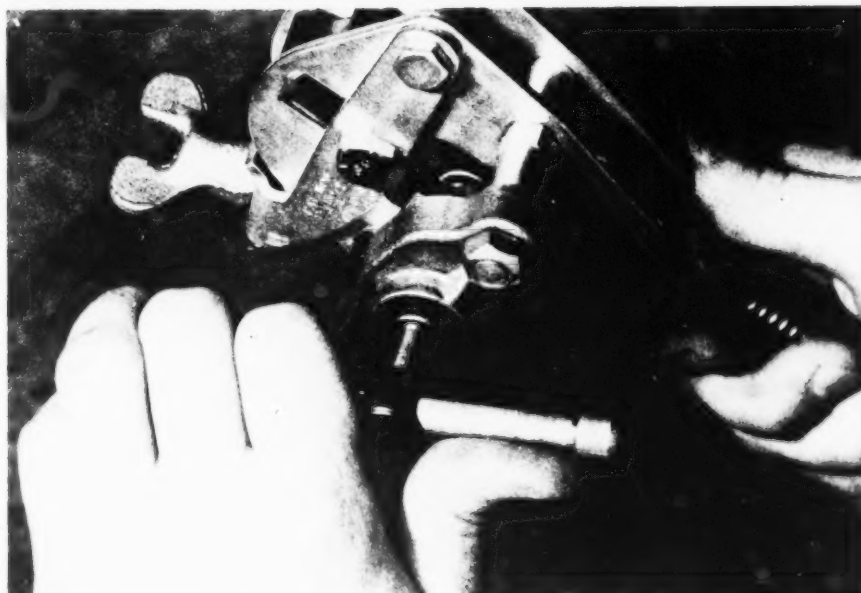
(NOTE: When the cone becomes hard to turn, the cone has bottomed out and any further turning will distort the flare.)

FIGURE 7



- G. Back the cone off and remove the tube from the flaring tool (Figure 8)

FIGURE 8



- H. Using the one-inch micrometer, measure the outside diameter of the flare
- (NOTE: The measurement should be 0.484 inches + 0.000 - 0.010 with a range of 0.474 to 0.484 inches.)
- I. If the flare is correct, continue with the rest of the steps in the project. If the flare is not within the above limits, cut the flare off (refer to step A) and repeat steps A-H
- J. When first flare is complete, measure and cut the piece of tubing to an overall length of 12-1/64 inches

(NOTE: When cutting tubing, it is important to produce a square end, free of burrs. Tubing may be cut with a tubing cutter or a hacksaw. The cutter can be used with any soft metal tubing, such as copper, aluminum, or aluminum alloy. Correct use of the tubing cutter is shown in Figure 9.

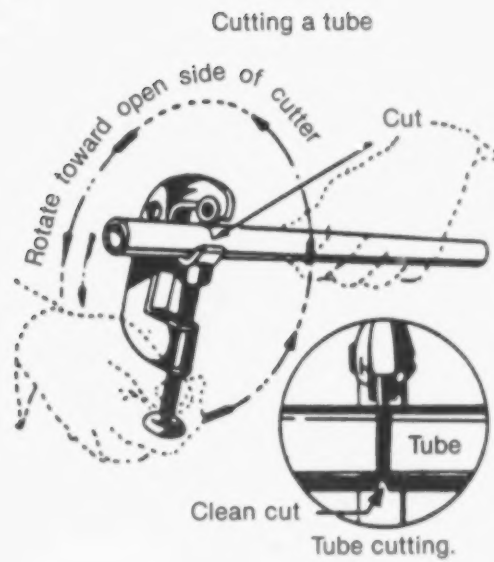
A new piece of tubing should be cut approximately 10 percent longer than the tube to be replaced to provide for minor variations in bending. Place the tubing in the cutting tool, with the cutting wheel at the point where the cut is to be made. Rotate the cutter around the tubing, applying a light pressure to the cutting wheel by intermittently twisting the thumbscrew. Too much pressure on the cutting wheel at one time could deform the tubing or cause excessive burring. After cutting the tubing, carefully remove any burrs from inside and outside the tube. Use a knife or the burring edge attached to the tubing center.)

(CAUTION: When performing the deburring operation, use extreme care that the wall thickness of the end of the tubing is not reduced or fractured. Very slight damage of this type can lead to fractured flares or defective flares which will not seal properly. A fine-toothed file can be used to file the end square and smooth.)

(NOTE: If a tubing cutter is not available, or if tubing of hard material is to be cut, use a fine-tooth hacksaw, preferably one having 32 teeth per inch. The use of a saw will decrease the amount of work-hardening of the tubing during the cutting operation. After sawing, file the end of the tube square and smooth, removing all burrs.

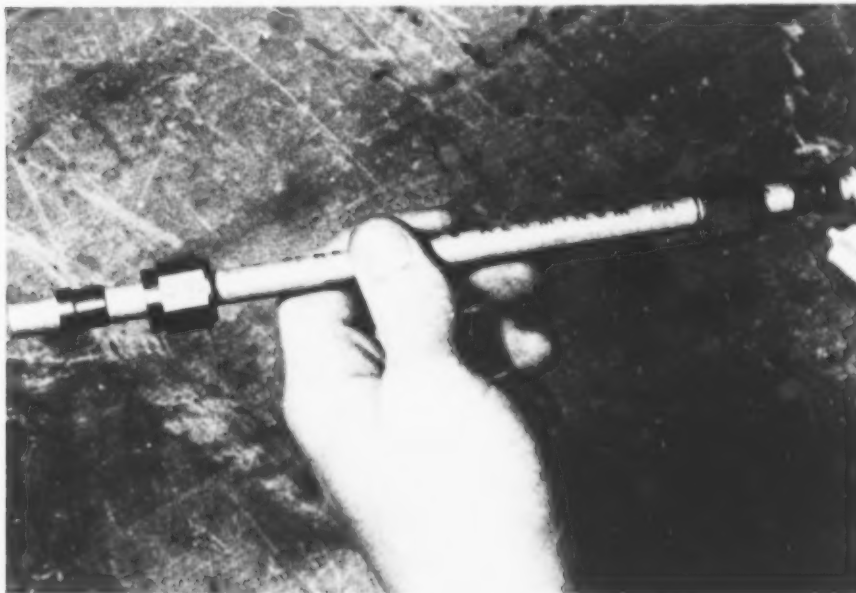
An easy way to hold small diameter tubing, when cutting it, is to place the tube in a combination flaring tool and clamp the tool in a vise. Make the cut about 1/2 inch from the flaring tool. This procedure keeps sawing vibrations to a minimum and prevents damage to the tubing if it is accidentally hit with the hacksaw frame or file handle while cutting. Be sure all filings and cuttings are removed from the tube.)

FIGURE 9



K. Install two B-nuts (AN818-6) and sleeves (AN819-6) (Figure 10)

FIGURE 10



PROJECT GUIDE #1

- L. Repeat steps A-H for the end of the tube not yet flared
- M. Measure the overall length of the tube. It should measure 12 inches + 1/64 inch with both flares being smooth and ready for pressure testing
- N. Have the tube assembly approved by the instructor
- O. Perform the pressure test of the tube assembly after the instructor has demonstrated operation of the tube tester and assigned a specific psi for testing the assembly
- P. Clean equipment; return equipment and materials to instructor

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PROJECT GUIDE #2--Perform Tube Bending

PURPOSE: To allow the student to develop skill in bending tubing and in using hand bending tools.

REFERENCE MANUALS: None

EQUIPMENT AND TOOLS NEEDED:

- A. Tubing Cutter
- B. Tube bender with 15/16-inch radius form block for 3/8-inch tubing
- C. 12-inch steel rule
- D. Machinist square

SUPPLIES AND MATERIALS:

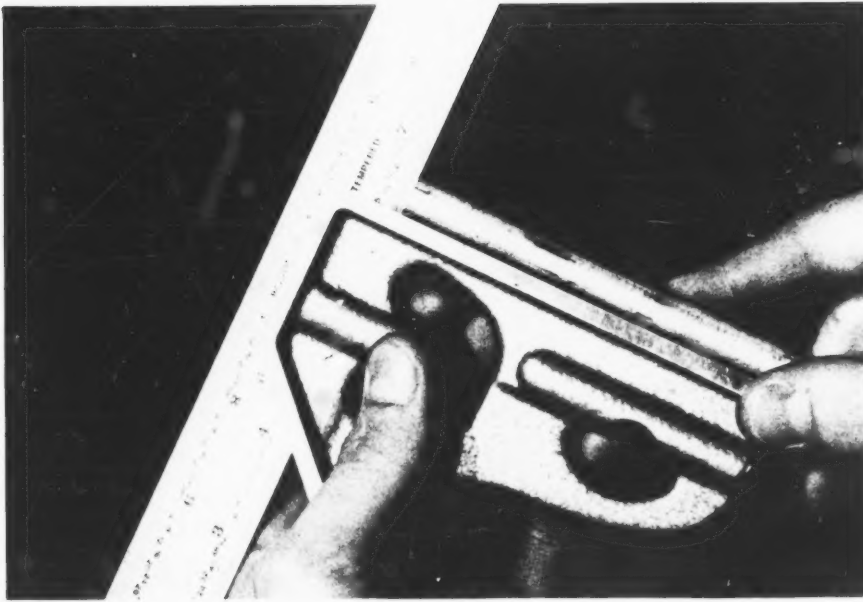
- A. One piece of aluminum tubing (5052 alloy is recommended) 3/8-inch gauge, 13 inches long
- B. One AN819 sleeve
- C. Sharp pencil
- D. One sheet of 500-grit wet or dry sandpaper

PROCEDURE:

(NOTE: The Imperial Lever Type tube bender is used in this project guide. However, any aircraft quality tube bender would be adequate to complete the project guide.)

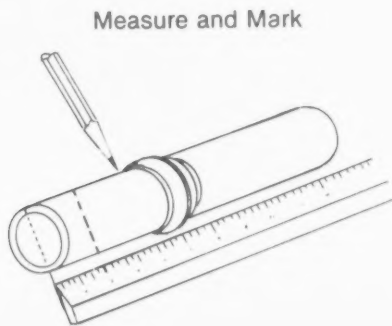
- A. Measure, mark, cut, and square both ends of the piece of tubing to a length of 12 inches (See Figure 11 on next page)

FIGURE 11



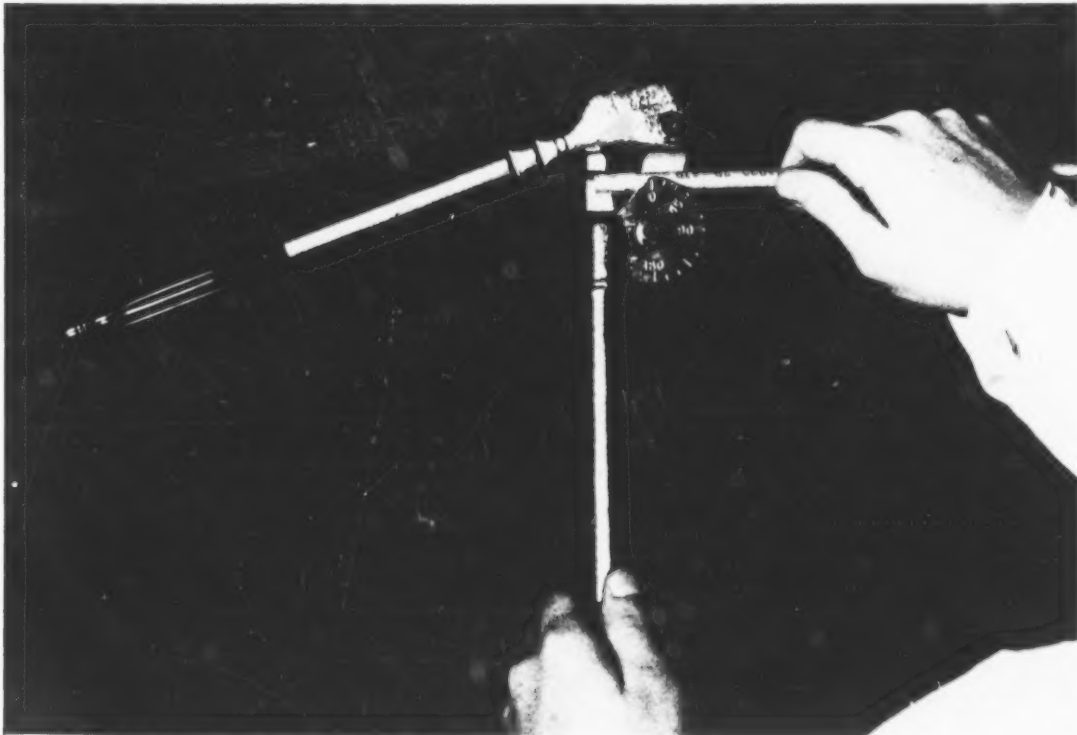
- B. Measure 2 inches in from one end of the tube and make a length mark with the pencil using the sleeve as a guide (Figure 12)

FIGURE 12



- C. Raise form handle and position tubing in grooves, making sure that the end from which the measurement was taken is to the left of the zero on the form wheel. Also be sure that the tube is secure in the tube clamp (Figure 13)

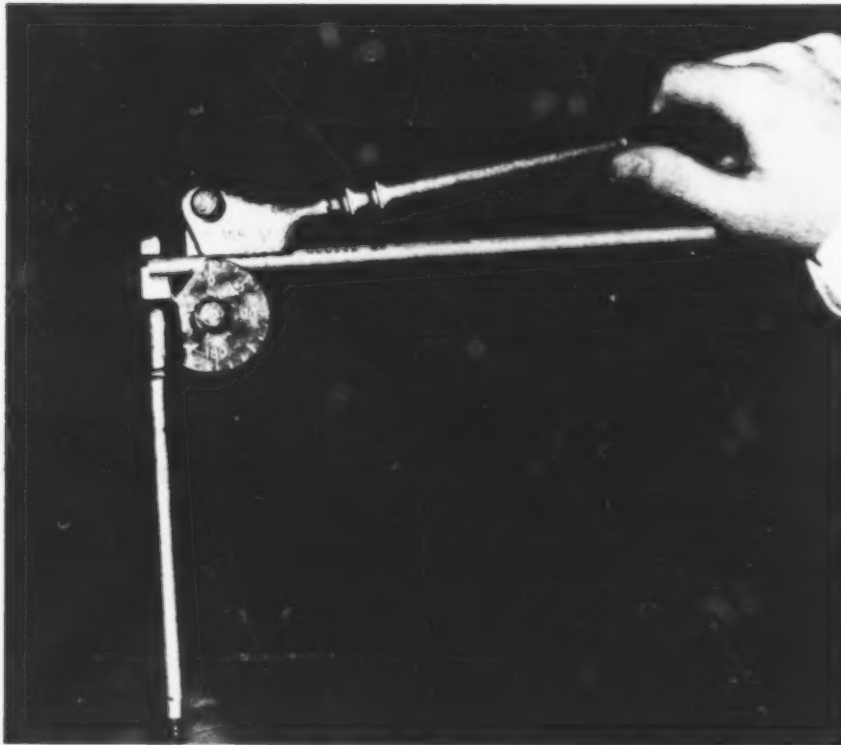
FIGURE 13



- D. Lower the form handle and align the length mark directly under the letter "L" on the right side of the form lever (See Figure 14)

(NOTE: Always try to bend away from the original starting end to avoid the complications caused by stretch as the tube is being bent. As long as the tube is measured and bent in the same direction, and measured centerline to centerline, "stretch" will not affect the actual center-to-center measurement. If the need arises for bend reversal, subtract one tube O.D. from the measured length for a 90° bend or one-half the O.D. for a 45° bend.)

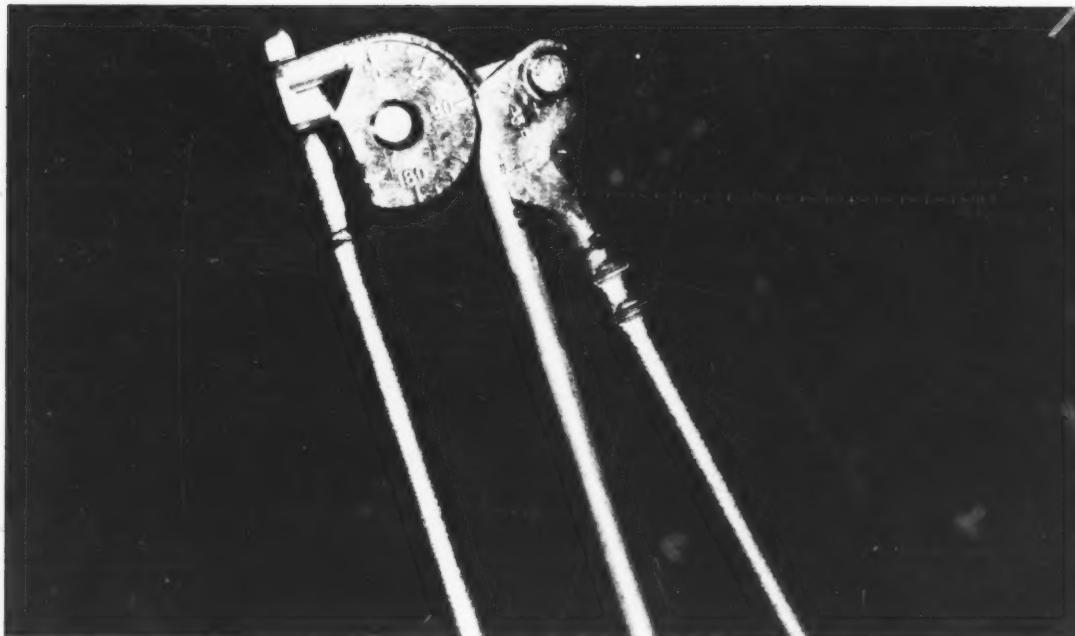
FIGURE 14



- E. Pull the lever handle in direction of arrow until the zero mark on the form lever coincides with the desired number of degrees (90°) on the form wheel (See Figure 15)

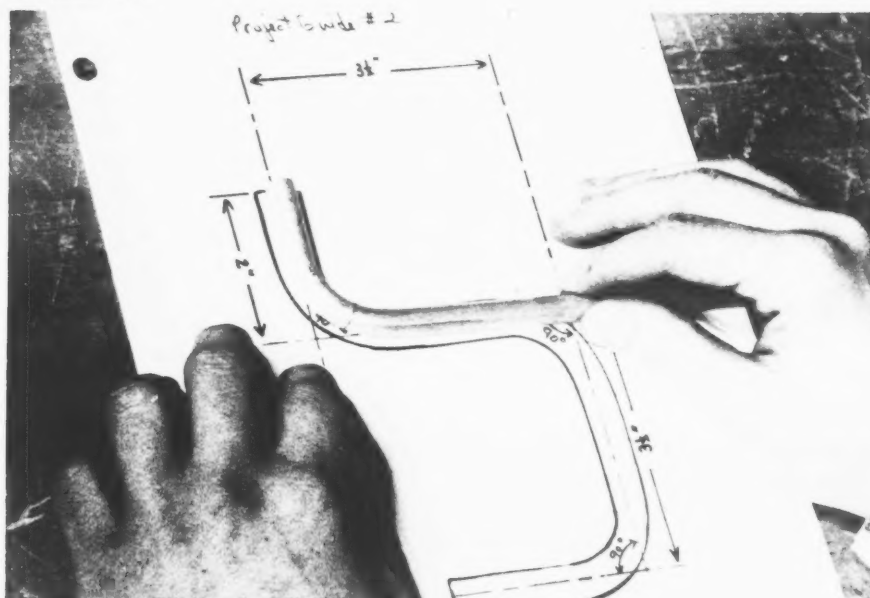
(NOTE: The tubing must be bent a few degrees past the intended angle mark due to springback. The best way to determine the actual amount of springback is by using a piece of scrap material, but a rule of 3° of springback for each 90° bend can generally be used.)

FIGURE 15



F. Remove the tube from the bender and place on the template provided with the project (Figure 16)

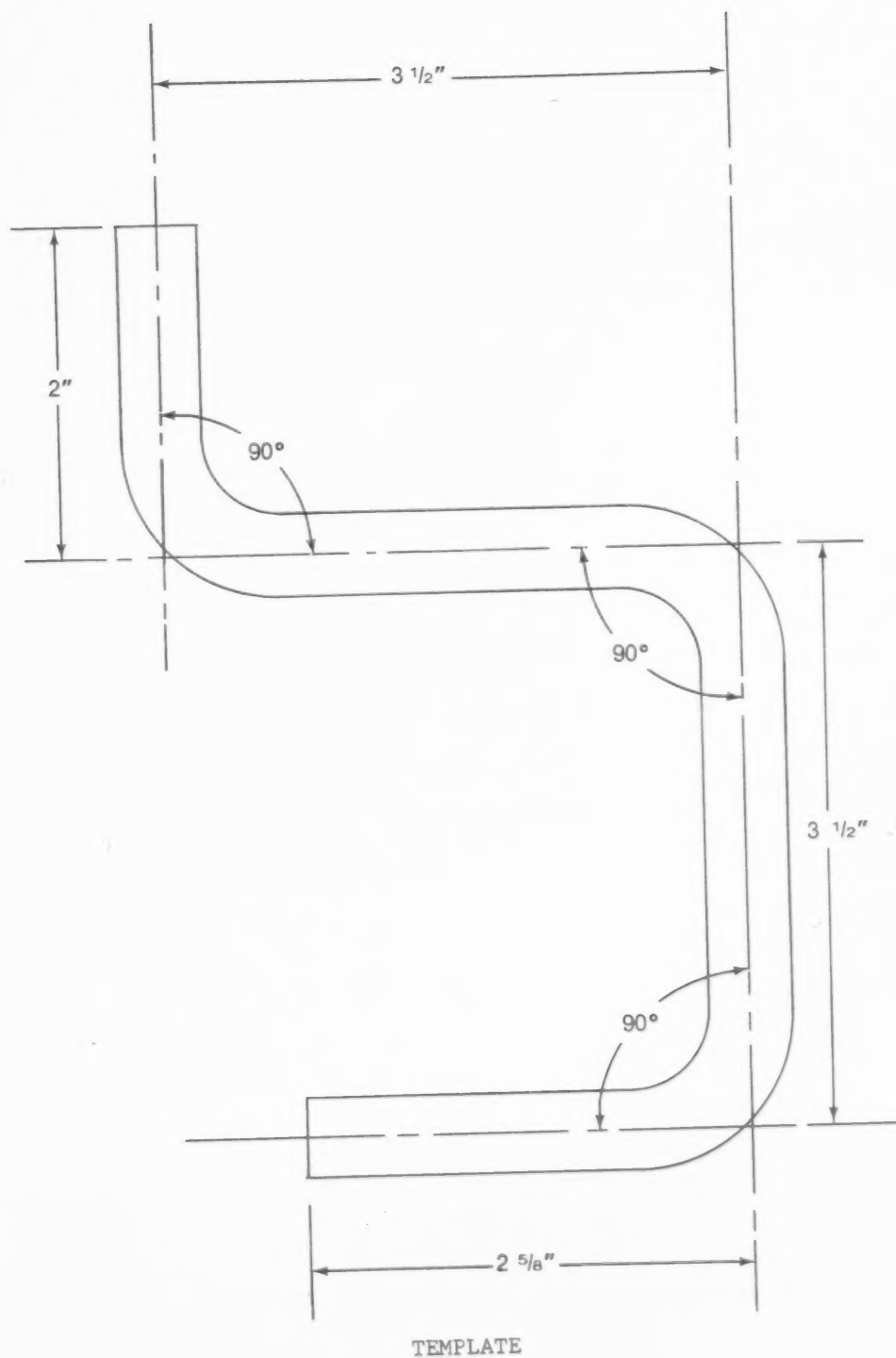
FIGURE 16



PROJECT GUIDE #2

- G. Mark the tube where the next centerline intersects; this provides the length mark for the next bend (See Figure 17 on next page)
- H. Repeat steps C-G for the remaining two bends
(NOTE: Keep all bends in the same plane.)
- I. Measure, mark, and trim excess tubing
(NOTE: The tube should now fit exactly on the template. If it does not, secure another length of tube and repeat all steps.)
- J. Clean equipment; return equipment and materials to instructor

FIGURE 17



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PROJECT GUIDE #3--Perform Tube Beading

PURPOSE: To allow the student to develop skill in tube beading and in using hand beading tools.

REFERENCE MANUAL: AC-65-9A

EQUIPMENT AND TOOLS NEEDED:

- A. Tubing cutter
- B. Beading tool
- C. Clamping tool

SUPPLIES AND MATERIALS:

- A. 3/8 O.D., 9 1/2 inch long piece of aluminum or steel tubing
- B. One sheet of 50C-grit wet or dry sandpaper
- C. Lubriplate grease
- D. Crocus cloth

PROCEDURE:

- A. Cut aluminum tubing to 8 inches
- B. Clean and polish both ends of tube with 500-grit wet or dry sandpaper

- C. Select correct size of beading tool

(NOTE: Refer to instructions in top of beading tool case.)

- D. Make sure clamping tool and tube are free from grease or oil and clamp the tube in the clamping tool securely (Figure 18)

(CAUTION: Tube will become deformed if clamped too tightly.)

FIGURE 18



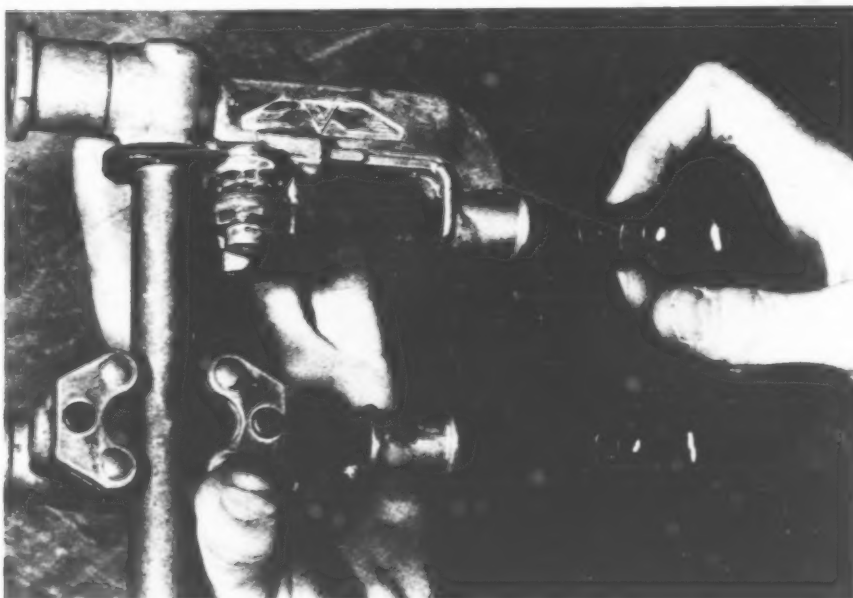
- E. Remove any grease and aluminum particles from the beading tool and apply a generous amount of clean grease to the rollers and mandrel (See Figure 19)

FIGURE 19



F. Position tubing over mandrel, making sure you have the end of the tube square against the rear of the mandrel (Figure 20)

FIGURE 20



- G. Form the bead by applying pressure on the tube and mandrel. To do this, tighten the rollers and rotate the beading tool around the tube (Figure 21)

(CAUTION: Do not try to form the bead too rapidly. This can cause the tube to crack, cause the mandrel to break, or create excessively deep tool marks around the bead. Form bead slowly and keep the tube completely on the mandrel.)

FIGURE 21



- H. Continue to form bead until proper dimension is achieved

(NOTE: See dimension sheet at end of project guide.)

- I. Clean and polish the bead area until all tool marks are removed (See Figure 22)

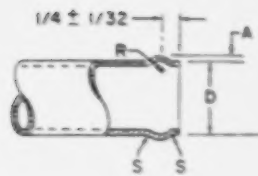
FIGURE 22



- J. Repeat steps D-I for other end of tube
- K. Clean equipment; return equipment and materials to instructor

PROJECT GUIDE #3

LOW-PRESSURE TUBING BEAD DIMENSIONS



Remove all burrs and sharp edges.
Dimensions in inches.

D Tube Outside Diameter	A +.003 Bead Height	R Max Radius	S Max Radius
1/4	.031	1/8	1/16
5/16	.033	1/8	1/16
3/8	.035	1/8	1/16
1/2	.038	1/8	1/16
5/8	.038	1/8	1/16
3/4	.038	1/8	1/16
1	.062	5/32	3/32
1-1/4	.062	5/32	3/32
1-1/2	.072	5/32	3/32
1-3/4	.072	5/32	3/32
2	.082	5/32	3/32
2-1/2	.082	5/32	3/32
3	.082	5/32	3/32

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PROJECT GUIDE #4--Fabricate Flareless Fitting Tube Assemblies

PURPOSE: To allow the student to develop skill in the fabrication of flareless fitting assemblies.

REFERENCE MANUAL: AC-65-9A

EQUIPMENT AND TOOLS NEEDED:

- A. Tubing cutter
- B. Tube tester
- C. Machinist square
- D. Bench vise
- E. Open-end wrench

SUPPLIES AND MATERIALS:

- A. One flareless fitting (MS-21918)
- B. Two sleeves and tube nuts (flareless)
- C. One piece of aluminum tubing (6061-T6) minimum length 8 inches
- D. 5606 hydraulic fluid (small amount)
- E. One sheet of 500-grit wet or dry sandpaper
- F. One flareless fitting-type plug (MS 21923)

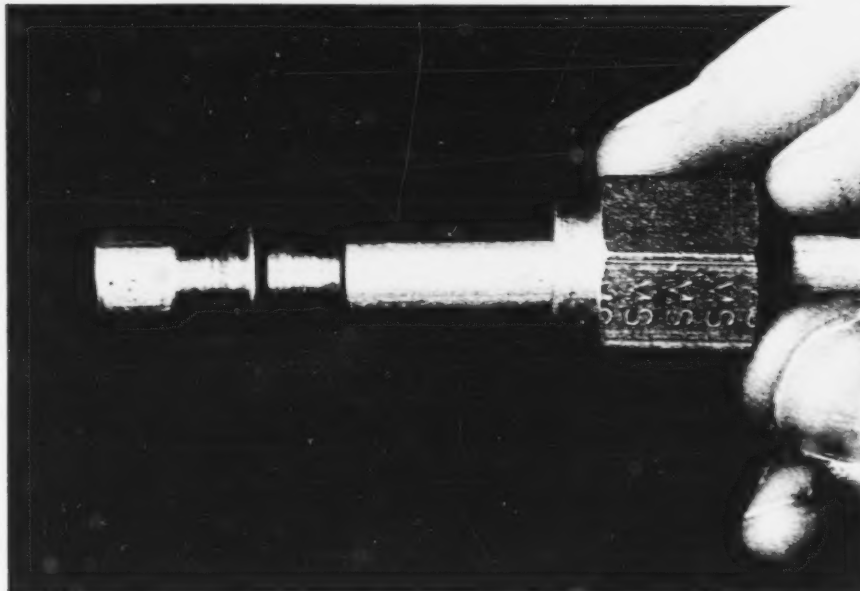
PROCEDURE:

- A. Cut a piece of aluminum tubing (6061-T6) 6 inches long, using the tubing cutter
- B. Deburr the tube's ends with tubing cutter knife and square both ends, using the machinist square and 500-grit sandpaper

(NOTE: If the tubing needs sanding to help square the ends, lay the 500-grit sandpaper on the anvil portion of the bench vise and sand the tube, using a figure-eight pattern.

C. Slip the nut, then the sleeve, over the tube (Figure 23)

FIGURE 23



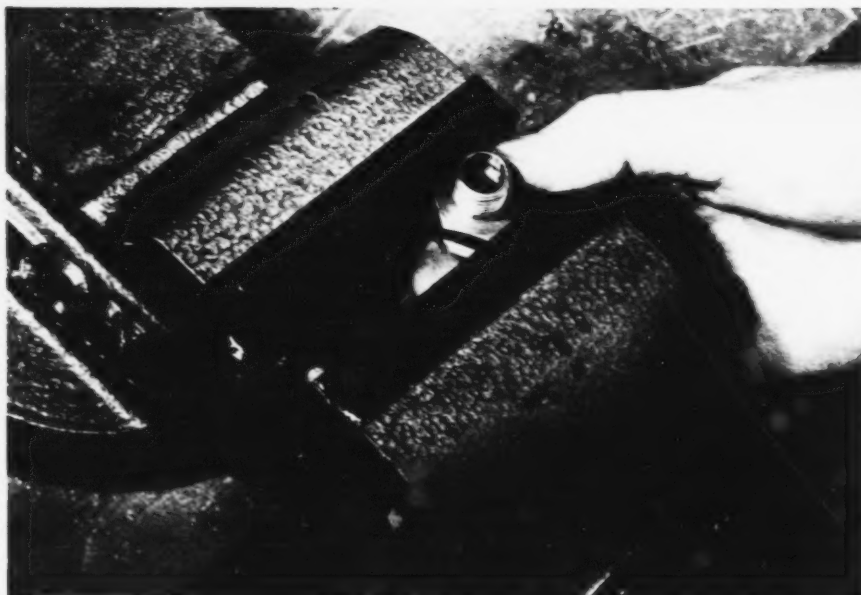
D. Lubricate the threads of the fitting and nut with hydraulic fluid (Figure 24)

FIGURE 24



E. Place the fitting in the vise (Figure 25)

FIGURE 25



F. Hold the tubing firmly and squarely on the seat in the fitting (Figure 26)

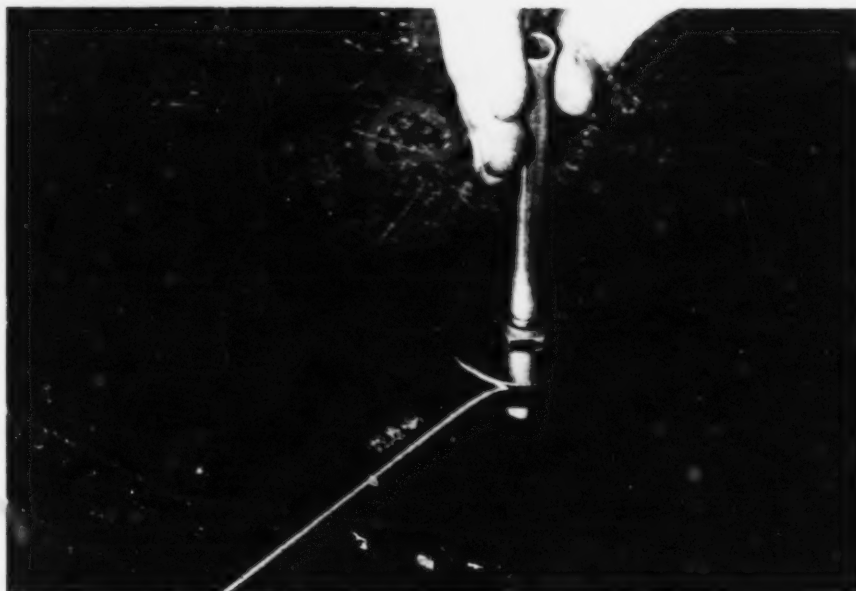
FIGURE 26



- G. Tighten the nut until the cutting edge of the sleeve grips the tube (Figure 27)

(NOTE: This point is determined by slowly turning the tube back and forth while tightening the nut. When the tube no longer turns, the nut is ready for final tightening.)

FIGURE 27



- H. Perform final tightening

(NOTE: For aluminum alloy tubing of up to 1/2-inch outside diameter, tighten the nut from one to 1 1/6 turns. For steel tubing and aluminum alloy of over 1/2-inch outside diameter, tighten from one to 1 1/2 turns.)

- I. After presetting the sleeve, disconnect the tubing from the fitting and check the following points:
1. The tube should extend 3/32 inch to 1/8 inch beyond the sleeve pilot; otherwise blowoff may occur
 2. The sleeve pilot should contact the tube or have a maximum clearance of 0.005 inch for aluminum alloy tubing or 0.015 inch for steel tubing
 3. A slight collapse of the tube at the sleeve cut is permissible. No movement of the sleeve pilot, except rotation, is permissible

PROJECT GUIDE #4

- J. Repeat steps C-I for the opposite end
- K. Using plug to block one end, attach assembly to tube tester and pressurize to psi specified by instructor
- L. Clean equipment; return equipment and materials to instructor

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PROJECT GUIDE #5--Fabricate a Double Flare

PURPOSE: To allow the student to develop the skills required to fabricate a double flare on tubing requiring a double flare.

REFERENCE MANUALS:

- A. AC-65-9A
- B. Manufacturer's instructional manual for the double flare tool

EQUIPMENT AND TOOLS NEEDED:

- A. 37° double flare tool

(NOTE: The Papco Model 600 Rotomaster 37° Precision Tube Flaring Tool is used in this project guide. If any other tube flaring tool is used, the project guide will need to be adjusted according to the manufacturer's instruction manual.)

- B. Tube cutter with burring knife
- C. Machinist square
- D. Bench vise

SUPPLIES AND MATERIALS:

- A. Supply of 1/4 inch (0.028 inch wall thickness) 5052-0 aluminum tubing
- B. Fine grit sandpaper

PROCEDURE:

(NOTE: A double flare should be used on 5052-0 and 6061-T aluminum alloy tubing for all sizes from 1/8-inch to 3/8-inch outside diameter. This is necessary to prevent cutting off the flare and failure of the tube assembly under operating pressures.)

(NOTE: Use Figure 40 at the end of the project guide to identify the parts of the double flare tool.)

(CAUTION: Tools should be installed in the bench vise whenever necessary to ease the operation and prevent damage to equipment.)

- A. Cut a piece of tubing from the shop supply approximately 4 inches long

- B. Burr the inside and outside of both ends of the tube with your burring knife
- C. Check for square using the machinist square and adjust as required with the fine grit sandpaper

(NOTE: Smooth the ends of the tubing with the sandpaper regardless of whether or not any adjustment is made for square.)

- D. Turn tube clamp screw No. 607 out to the limit (Figure 28)

FIGURE 28



(NOTE: This will allow the clearance necessary to either remove or install the tube clamp blocks Nos. 604 and 605.)

- E. Select clamp blocks having proper size openings to accommodate the size tube to be flared (blocks are stamped showing sizes) (See Figure 29)

(NOTE: See that the openings in these clamp blocks pair up to the center of the two blocks when installed, making a circular opening to receive the size tubing selected.)

FIGURE 29



F. Turn compression screw No. 617 out far enough to allow retcr No. 603 to revolve (Figure 30)

(NOTE: Allow compression screw No. 617 to remain in this position.)

FIGURE 30



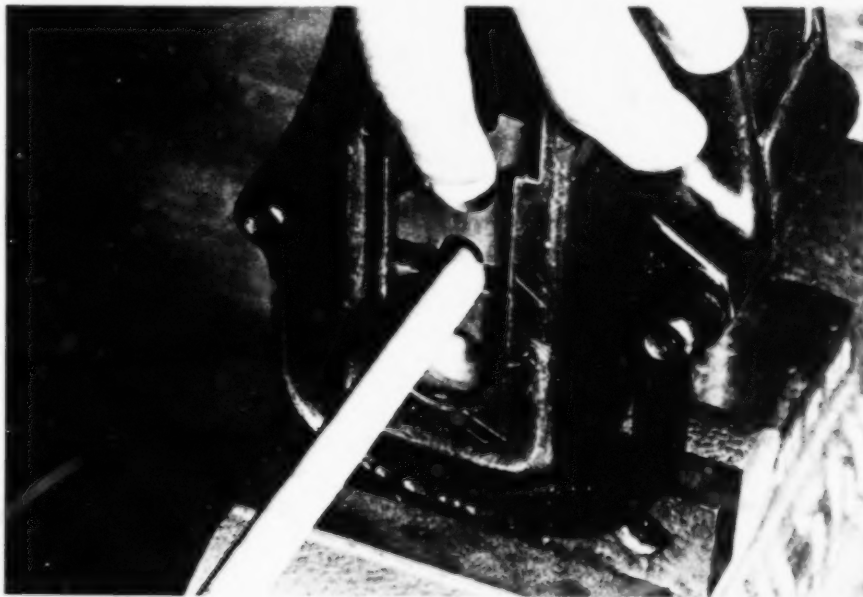
- G. Revolve rotor NO. 603 until tube size appears in small sight opening at the top of the tool (Figure 31)

FIGURE 31



- H. Open clamping blocks slightly to allow tube entry; and compression screw still in the OUT position, insert the tube until it is solidly connecting the first operation punch (Figure 32)

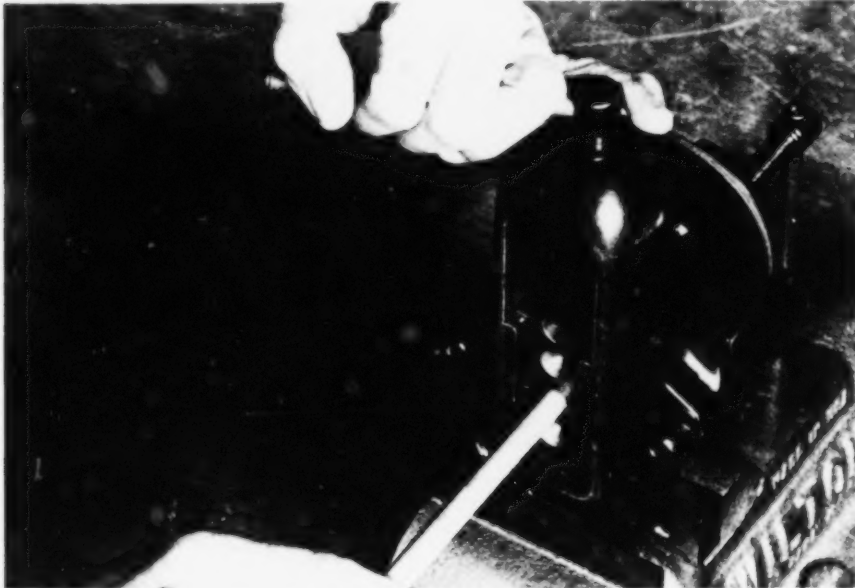
FIGURE 32



- I. Hold the tube firmly against this punch and firmly tighten clamp screw No. 607 (Figure 33)

(NOTE: The tool is then ready to complete the first operation of flare.)

FIGURE 33



- J. Tighten the compression screw No. 617 down as far as it will travel (Figure 34)

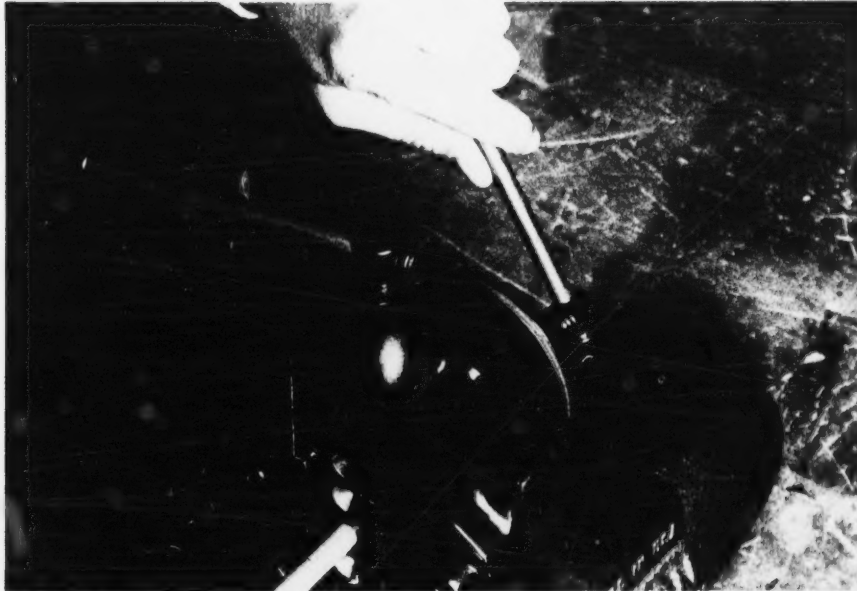
(NOTE: The larger diameter tubes will require slightly more pressure in this operation than the smaller tubes.)

FIGURE 34



K. Turn the compression screw back to the OUT position (Figure 35)

FIGURE 35



L. Revolve the rotor until the word "cone" appears in the sight window (Figure 36)

FIGURE 36



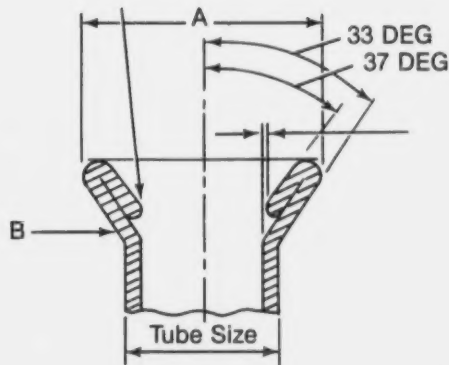
- M. Tighten the compression screw until the proper amount of flare is obtained or until a slight resistance of the screw is noted (See Figures 37-39).

(NOTE: This completes the double flare. Use the dimensions provided to determine the size appropriate for your tubing. Under flaring is more desirable than over flaring due to the drawup of the fittings.)

FIGURE 37



FIGURE 38



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FIGURE 39

Tube Size Nominal Outside Diameter (in.)	A Diameter +0.010 -0.010 (in.)	B Radius +0.010 (in.)	Wall Thickness (in.)	Minimum Inside Diameter (in.)
1/8	0.224	0.032		
3/16	0.302	0.032	0.028	0.114
			0.035	0.100
1/4	0.359	0.032	0.028	0.178
			0.035	0.159
5/16	0.421	0.032	0.035	0.224
			0.049	0.198
3/8	0.484	0.046	0.028	0.310
			0.035	0.288
			0.049	0.261

Dimensional tolerances for a double flare on a piece of aircraft rigid tubing

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- N. Release the tubing from the tool by turning the clamp screw No. 607 back approximately 3/4 inch; separating the clamp blocks (See Figure 40)
- O. Repeat steps F through N for the opposite end of the tube
- P. Have your instructor evaluate your flares; reflare as necessary
- Q. Clean equipment; return equipment and materials to instructor

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PROJECT GUIDE #6--Fabricate Flexible Hose Assembly

PURPOSE: To allow the student to develop skill in the fabrication of flexible hose assemblies and in the correct use of the tools used to fabricate a flexible hose assembly.

REFERENCE MANUALS: AC-65-9A

EQUIPMENT AND TOOLS NEEDED:

- A. Fine-tooth hacksaw
- B. Open-end wrench
- C. Bench vise
- D. Flexible hose assembly tool or a mating AN815 adapter

SUPPLIES AND MATERIALS:

- A. Length of flexible hose
- B. Light oil
- C. End fittings
- D. Grease pencil

PROCEDURE:

- A. Select the proper size hose and end fittings

PROJECT GUIDE #6

- B. Cut the hose to proper length using a fine-tooth hacksaw
- C. Place the socket in the bench vise (Figure 41)

FIGURE 41



- D. Screw the hose into the socket counterclockwise until the hose bottoms on the shoulder of the socket; then back off 1/4 turn (Figure 42)

FIGURE 42



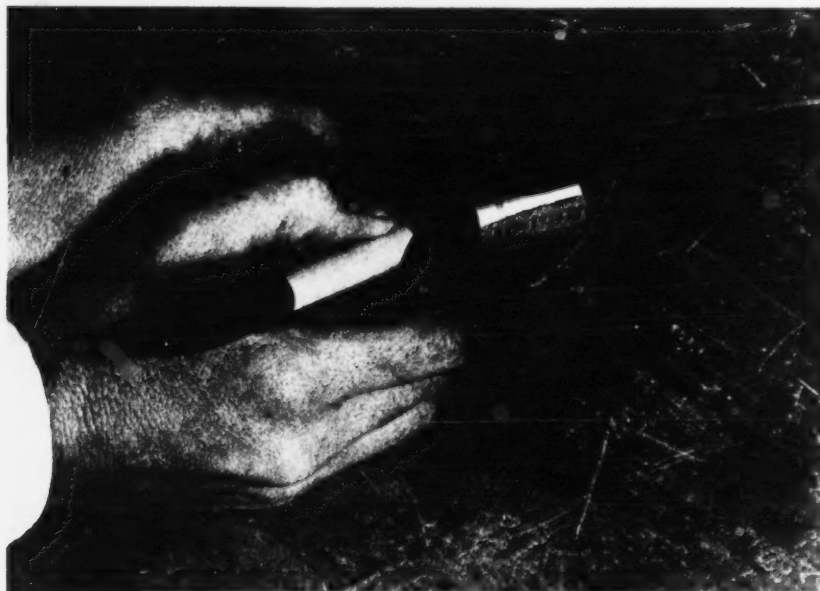
- E. Lubricate inside of hose and nipple threads liberally with light oil (Figure 43)

FIGURE 43



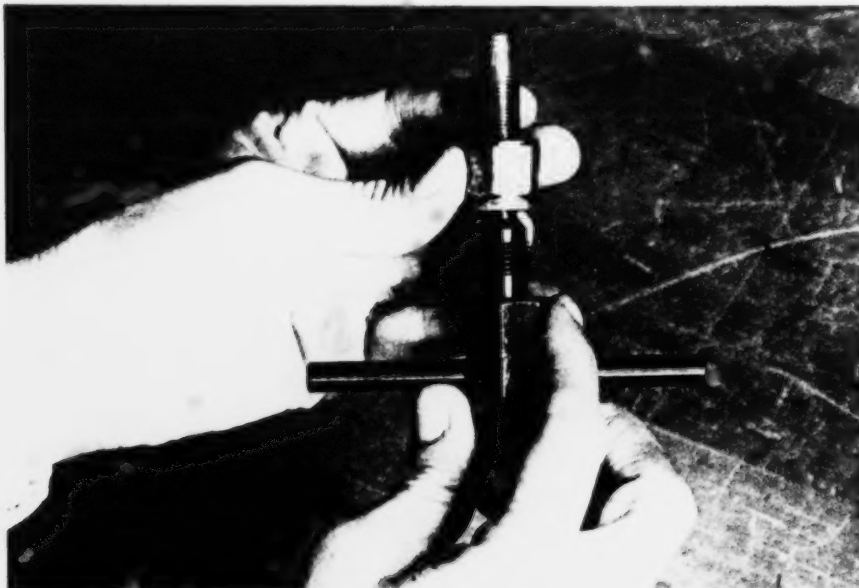
- F. Mark the hose position around the hose at the rear of the socket using a grease pencil or painted line (Figure 44)

FIGURE 44



- G. Insert the nipple into the nut and tighten both onto the assembly tool (Figure 45)

FIGURE 45



- H. Screw the nipple into the socket and hose, using the open-end wrench on the assembly tool (Figure 46)

(NOTE: A 1/32-inch to 1/16-inch clearance between the nut and sleeve is required so that the nut will swivel freely when the assembly tool is removed.)

FIGURE 46



PROJECT GUIDE #6

- I. Repeat steps C-H for opposite end
- J. Remove all foreign matter from the inside of the hose by blowing out with compressed air
- K. Clean equipment; return equipment and materials to instructor

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PROJECT GUIDE #7--Install Rigid and Flexible Fluid Lines

PURPOSE: To allow the student to develop skill in the installation of rigid tube and flexible hose assemblies and in using the correct hand tools, torques, manuals, and clamping procedures.

REFERENCE MANUALS:

- A. AC-65-9A 115-119
- B. AC-43:13-1A2 169, 170
- C. EA-ITP-G 4:75-78
- D. Applicable manufacturer's manuals

MENT AND TOOLS NEEDED:

- A. Installation mock-up or aircraft engine with both rigid tubing and flexible hose-type plumbing
- B. Set of combination wrenches
- C. Phillips screwdriver #2

SUPPLIES AND MATERIALS:

- A. Tube and hose assemblies for mock-up or engine
- B. Ten screws and nuts (10-32)
- C. Support clamps

PROCEDURE:

(NOTE: This project requires two- to four-man crews.)

- A. Review all applicable manufacturer's manuals and advisory circulars for details concerning installation procedures
- B. Install rigid tubing and support clamps according to reference manual instructions
- C. Have instructor inspect your work

PROJECT GUIDE #7

- D. Install flexible hose and support clamps according to reference manual instructions
- E. Have instructor inspect work
- F. Remove all hoses and rigid tubing and clamps after project is complete and instructor directs you to do so
- G. Clean equipment; return equipment and materials to instructor

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THEORY TEST

1. Match terms related to rigid and flexible fluid lines and fittings to their correct definitions. Write the correct numbers in the blanks.

- | | |
|---|---|
| ----- a. Thickness of the material used to form rigid tubing, measured in thousandths of an inch | 1. Tube bead |
| ----- b. Process of joining two or more chemicals with molecules of similar structure, forming a more complex molecule with different physical properties | 2. Boosted flight controls (boost system) |
| ----- c. Movement of one object with relation to another | 3. Polymerization |
| ----- d. Hydraulically actuated system which aids the pilot in operation of the controls | 4. Fitting |
| ----- e. Bulge at the end of a tube used in conjunction with flexible hose and hose clamps | 5. Flareless fitting |
| ----- f. Part used to join or attach assemblies together | 6. Aircraft plumbing |
| ----- g. Hoses, tubing, fittings, and connectors used for carrying fluids through an aircraft | 7. Relative movement |
| ----- h. Form of fluid line fitting used on some hydraulic brake lines in which a sleeve is forced into the tube to form the sealing surface | 8. Wall thickness |

THEORY TEST

- | | |
|--|-----------------------------|
| ----- i. Synthetic, non-flammable, ester-base hydraulic fluid used in modern high-temperature hydraulic systems | 9. Radius block |
| ----- j. Branch of science that deals with the transmission of power by incompressible fluids under pressure | 10. Hydraulics |
| ----- k. Any of numerous devices by which the flow of liquid or gas may be started, stopped, or regulated by a movable part that opens, shuts, or partially obstructs one or more parts or passages; the movable part of such a device | 11. Mandrel |
| ----- l. Metal block around which sheet metal is bent to obtain a specific bend radius | 12. Skydrol hydraulic fluid |
| ----- m. Oil-resistant synthetic rubber made by polymerizing chloroprene | 13. Neoprene |
| ----- n. Metal device that serves as a core around which material may be cast, molded, forged, bent, or otherwise shaped | 14. Valve |
| ----- o. Roughening or wearing away of a surface by scratches or marks usually caused by foreign matter between moving parts or surfaces | 15. Abrasion |

THEORY TEST

- | | |
|--|-----------------|
| _____ p. Yellow, red, or white stripe running the length of a flexible hose | 16. Butyl |
| _____ q. To cause to form crystals or assume crystalline form | 17. Alloy |
| _____ r. Proprietary name for a flurocarbon resin used to make hydraulic and pneumatic seals, and backup rings | 18. Burr |
| _____ s. Substance of different elements, one of which is a metal | 19. Buna-N |
| _____ t. Sharp or rough projection of metal usually resulting from machine processing | 20. Teflon |
| _____ u. One of several rubbers made by polymerization or copolymerization of butadiene | 21. Crystallize |
| _____ v. Trade name of a synthetic rubber product made by the polymerization of isobutylene | 22. Lay line |
2. Select statements related to materials and size designations of rigid tubing. Circle the number before the correct answer.
- a. Which of the following tubings has the characteristics (medium-strength, workability) necessary for use in a medium-pressure (1,500 psi) hydraulic system?
- 1) 2024-T or 5052-0 aluminum alloy
 - 2) Copper or hard plastic
 - 3) 1100-1/2-H or 3003-1/2-H aluminum alloy
 - 4) Carbon steel or chrome molybdenum
- b. The material specifications for a certain aircraft require that a replacement oil line be fabricated from 3/4-inch, 0.072 5052-0 aluminum alloy. What is the inside dimension of this tubing?
- 1) 0.0606 inch
 - 2) 0.572 inch
 - 3) 0.688 inch
 - 4) 0.750 inch

THEORY TEST

- c. Select the coupling nut which should be used with 1/2-inch aluminum oil lines which are to be assembled using flared tube ends and standard AN nuts, sleeves, and fittings.
- 1) AN818-2
 - 2) AN818-8
 - 3) AN818-5
 - 4) AN818-12
- d. Which of the following tubings has the characteristics (high-strength, abrasion-resistance) necessary for use in a high-pressure (3,000 psi) hydraulic system for operation of landing gear and flaps?
- 1) Copper or hard plastic
 - 2) 2024-T or 5052-O aluminum alloy
 - 3) Corrosion-resistant steel annealed or 1/4-H
 - 4) 110-1/2-H or 3003-1/2-H aluminum alloy
3. Select statements related to the fabrication of rigid tubing assemblies. Circle the number before the correct answer.
- a. When flaring aluminum tubing for use with AN coupling nuts and sleeves, the flare angle should be
- 1) 30°
 - 2) 37°
 - 3) 67°
 - 4) 45°
- b. In most aircraft hydraulic systems, two-piece tube connectors consisting of a sleeve and a nut are used when a tubing flare is required. The use of this type of connector eliminates
- 1) The need for flexible lines interconnecting movable and stationary components
 - 2) The flaring operation prior to assembly
 - 3) The possibility of reducing the flare thickness by wiping or ironing during the tightening process
 - 4) Wrench damage to the tubing during the tightening process

THEORY TEST

- c. What is an advantage of a double flare on aluminum tubing?
- 1) It is less concentric than a single flare
 - 2) Ease of construction
 - 3) It is less resistant to the shearing effect of torque
 - 4) It is more resistant to the shearing effect of torque
- d. Soft aluminum tubing (110, 3003, or 5052) may be bent by hand if the size is
- 1) 5/16 inch or less
 - 2) 7/16 inch or less
 - 3) 5/8 inch or less
 - 4) 1/4 inch or less
- e. Which of the following statements about MS (Military Standard) flareless fittings is correct?
- 1) MS flareless fitting sleeves must not be present on the line prior to final assembly
 - 2) During installation, MS flareless fittings are normally tightened by turning the nut a specified amount after the sleeve and fitting sealing surface have made contact, rather than by being torqued
 - 3) MS flareless fittings should not be lubricated prior to assembly
 - 4) MS flareless fittings should not be tightened to a specific torque

THEORY TEST

- f. From the following sequences of steps, indicate the proper order you would use to make a single flare on a piece of tubing.

(NOTE: Steps A-F are scrambled. Find the correct sequence by referring to the numbers at the end of this test question. Circle the correct number.)

- A. Place the tube in the proper size hole in the flaring block
- B. Project the end of the tube slightly from the top of the flaring tool, to about the thickness of a dime
- C. Slip the fitting nut and sleeve on the tube
- D. Strike the plunger several light blows with a lightweight hammer or mallet and turn the plunger one-half turn after each blow
- E. Tighten the clamp bar securely to prevent slippage
- F. Center the plunger or flaring pin over the tube

- 1) F,E,B,A,D,C.
- 2) A,C,E,B,D,F
- 3) C,A,F,B,E,D
- 4) C,B,F,E,A,D

- g. When installing a hydraulic line, the tube flare should meet the fitting squarely and fully before the nut is started. The flare should never be drawn to the fitting with the nut because this may

- 1) Deform the line
- 2) Strip the threads on the fitting
- 3) Deform the flare
- 4) Strip the threads on the nut

(NOTE: Test questions 4-8 are project guides. They are an important part of this test. If they have not been completed, check with your instructor.)

- 4. Perform tube flaring.
- 5. Perform tube bending.
- 6. Perform tube beading.
- 7. Fabricate flareless fitting tube assemblies.

THEORY TEST

8. Fabricate a double flare.

9. State facts related to hose construction.

a. What is flexible hose used for in aircraft plumbing?

b. What are the four synthetic compounds used for the inner liners in aircraft flexible fluid lines?

1) -----
2) -----
3) -----
4) -----

10. Select statements related to the measurement and identification of flexible fluid lines. Circle the number before the correct answer.

a. Flexible hose used in aircraft plumbing is classified in size according to the

- 1) Outside diameter
- 2) Cross-sectional area
- 3) Wall thickness
- 4) Inside diameter

b. The information printed on the outer cover of aircraft-type flexible hose stock consists of which set of facts?

- 1) MIL-spec number, manufacturer's symbol, year and quarter of manufacture, and size dash number
- 2) FAA-PMA number, manufacturer's symbol, year and quarter of manufacture, and size dash number
- 3) MIL-spec number, manufacturer's symbol, year of manufacture, and size dash number
- 4) MIL-spec number, manufacturer's symbol, year of manufacture, wall thickness, and size dash number

THEORY TEST

11. Distinguish between the characteristics of low-, medium-, and high-pressure hose by writing an "L" in the blanks before characteristics of low-pressure hose, "M" before characteristics of medium-pressure hose, and "H" before characteristics of high pressure hose.

- _____ a. Seamless inner tube and a reinforcement made of a single layer of cotton braid
- _____ b. Uses two or more steel braids
- _____ c. An outer cover of ribbed or smooth rubber is used to protect the reinforcement from physical abuse
- _____ d. Called 1,500 psi tubing
- _____ e. Outer cover is smooth
- _____ f. Outer cover is black and has a yellow lay line
- _____ g. Seamless inner tube and a cotton braid impregnated with a rubber-type compound to securely bond the single steel braid to the inner tube

12. Select statements related to the construction, usage, and advantages of Teflon hose. Circle the number before the correct answer.

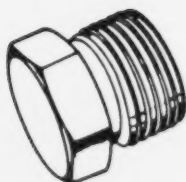
- a. The principal advantage of Teflon hose is
 - 1) Its operating strength
 - 2) Its low cost
 - 3) Its corrosion resistance
 - 4) Its flexibility
- b. A seamless extruded inner liner of Teflon resin is covered with a stainless steel braid for what type of application?
 - 1) High-pressure
 - 2) Medium-pressure
 - 3) Alternating-pressure
 - 4) Low-pressure

THEORY TEST

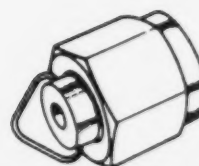
- c. One important point to remember when installing Teflon hose is
- 1) Never route this hose under a fuel line because this type of hose is affected by fuel
 - 2) Never route this hose under a lubrication line because this type of hose is affected by oil
 - 3) Be sure to observe minimum bend radius restrictions when installing Teflon hose
 - 4) Always straighten the portion of hose which has acquired a "set"
13. State facts related to methods used for attaching fluid line fittings to components.
- a. What are the two types of fittings used to attach a fluid line to a casting?
- 1) _____
 - 2) _____
- b. What precaution must be taken when screwing a tapered pipe thread into a cast aluminum or magnesium housing? _____
- _____
- _____
- c. What is the advantage of a universal bulkhead fitting over a tapered pipe thread? _____
- _____
- _____
14. State facts related to flared fittings used to connect rigid fluid lines.
- a. Name the color used to identify an AN aluminum flare-type fitting.
- _____
- b. Name the type of fitting which can be identified by the shoulder between the end of the threads and the flare cone.
- _____

THEORY TEST

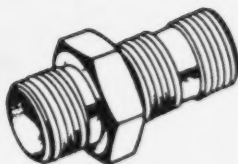
15. Identify typical flareless fittings. Write the correct names in the blanks.



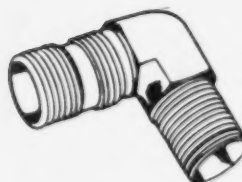
a. _____



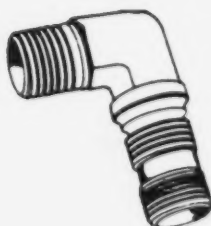
b. _____



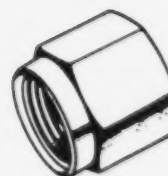
c. _____



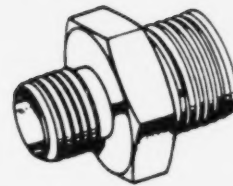
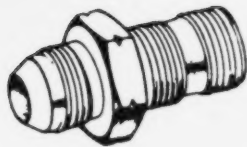
d. _____



e. _____



f. _____



g. _____ h. _____

16. Select statements related to fittings for flexible hose. Circle the number before the correct answer.

a. If failure of a flexible hydraulic hose equipped with swaged-on fittings occurs, which of the following repair procedures should be followed?

- 1) Insert a nonmetallic hose liner which is approved for use with the type of fluid contained in the system, and clamp firmly at both ends.
- 2) Remove the hose fittings and reuse on a new flexible line of the correct length
- 3) Replace the hose with rigid tubing equipped with end fittings of the same type as those used in parts of the system
- 4) Install a replacement hose of the proper length which has been factory-equipped with swaged-end fittings

b. Reusable fittings normally have the following three pieces

- 1) Nut, washer, nipple
- 2) Socket, nipple, nut
- 3) Socket, washer, nut
- 4) Nipple, nut, washer

THEORY TEST

- c. To properly check a newly fabricated flexible hose, a technician uses a hydrostatic test. This test pressurizes the hose to
- 1) Twice its normal operating pressure, and holds this pressure for between one and five minutes
 - 2) One-half its normal operating pressure, and holds this pressure for between five and ten minutes
 - 3) Three times its normal operating pressure, and holds this pressure for between one and five minutes
 - 4) One and one-half its normal operating pressure, and holds this pressure for between one and five minutes
- d. Flexible hose may be used in aircraft fluid systems
- 1) To replace only low-pressure fluid systems lines
 - 2) To replace any fluid system line not subject to heat
 - 3) According to the manufacturer's specifications
 - 4) To replace any fluid system line

(NOTE: Test question 17 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

17. Fabricate flexible hose assemblies

18. Select statements concerning the routing, securing, servicing, and identification marking used in fluid line installation. Circle the number before the correct answer.

(NOTE: Read both statements A and B and circle the number before the correct response.)

- a. 1) Bonded clamps are used for support when installing metal tubing
- 2) Unbonded clamps are used for support when installing wiring

Concerning the above statements

- 1) Only B is true
- 2) Only A is true
- 3) Both A and B are true
- 4) Neither A nor B is true

THEORY TEST

- b. In a metal tubing installation,
 - 1) Rigid straight line runs are preferable
 - 2) Tension is undesirable because pressurization will cause it to expand and shift
 - 3) A tube may be pulled in line if nut will start on threaded coupling
 - 4) Tension is desirable because the metal tubing cannot shift when pressurized
- c. A fluid line marked with the letters PHDAN
 - 1) Carries hydraulic fluid back to the reservoir
 - 2) Is a high-pressure fluid line. The letters mean Pressure High, Discharge at Nacelle
 - 3) Is carrying a fluid which may be dangerous to personnel
 - 4) Must be made of a nonphosphorous metal
- d. When installing bonded clamps to support metal tubing
 - 1) Paint removal from tube is unnecessary as it will inhibit corrosion
 - 2) Paint clamp and tube, after clamp installation, for slippage identification
 - 3) Paint clamp and tube, after clamp installation, to prevent corrosion
 - 4) Remove paint or anodizing from tube at clamp location
- e. If it is necessary to route hydraulic lines and electrical power cables adjacent to each other, the electrical cable should be
 - 1) Routed below the hydraulic line and clamped securely to the structure
 - 2) Routed above the hydraulic line and clamped securely to the structure
 - 3) Attached securely to the line by clamps that will maintain a separation between the line and cable equal to at least four times the diameter of the fluid line
 - 4) Grounded at intervals not to exceed four times the distance separating the fluid line and the cable

THEORY TEST

- f. Scratches or nicks on the straight portion of aluminum alloy tubing may be repaired if they are no deeper than
 - 1) 20 percent of the wall thickness
 - 2) 1/32 inch
 - 3) 1/16 inch
 - 4) 10 percent of the wall thickness
- g. Hydraulic line located in entryways or passenger, crew, or baggage compartments
 - 1) Should be suitably supported and protected against physical damage
 - 2) Are not normally permitted
 - 3) Must be routed in separate enclosures which must be drained and vented to the outside atmosphere
 - 4) Must not contain any fittings or connections within the entryways or compartments
- h. High-pressure hydraulic tubing, which is damaged in a localized area to such an extent that repair is necessary, may be repaired
 - 1) With a union and two sets of connecting fittings
 - 2) Only by replacing the entire tubing using the same size and material as the original
 - 3) By cutting out the damaged section of tubing and installing a piece of high-pressure flexible hose with hose clamps
 - 4) By cutting out the damaged section and welding in a replacement section of tubing
- i. The maximum distance between end fittings to which a straight hose assembly is to be connected is 50 inches. The minimum hose length to make such a connection should be
 - 1) 54 1/2 inches
 - 2) 50 3/4 inches
 - 3) 51 inches
 - 4) 52 1/2 inches

THEORY TEST

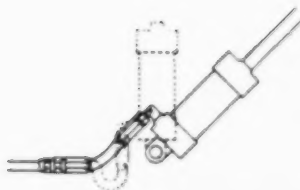
j. Flexible lines should be installed

- 1) Where bends are necessary
- 2) Only aft of the firewall
- 3) With just enough slack to make the connection
- 4) With 5 to 8 percent slack

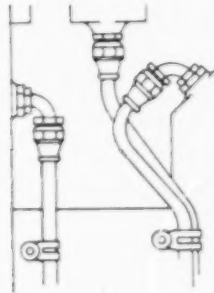
k. A scratch or nick in aluminum alloy tubing can be repaired by burnishing provided the scratch or nick does not

- 1) Exceed 5 percent of the tube diameter
- 2) Appear in the heel of a bend in the tube
- 3) Exceed 20 percent of the wall thickness of the tube
- 4) Exceed 10 percent of the tube diameter

19. Distinguish between correct and incorrect flexible hose and rigid tubing installations. Write "correct" or "incorrect" in the blanks.

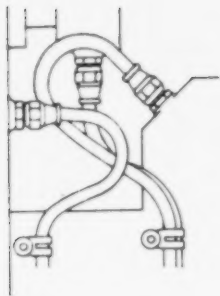


a. _____

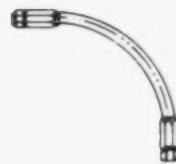


b. _____

THEORY TEST



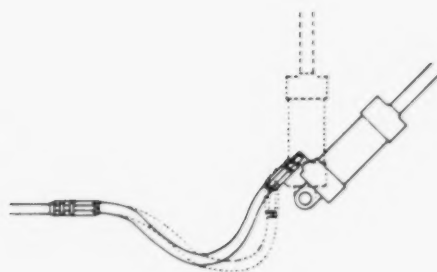
c. _____



d. _____



e. _____

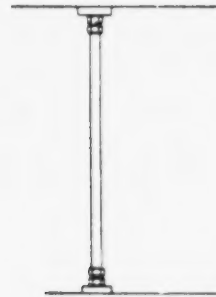


f. _____

THEORY TEST



g. _____



h. _____

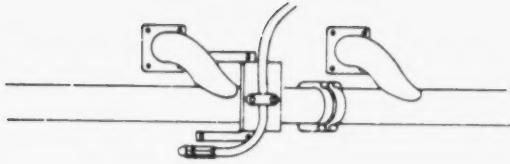


i. _____

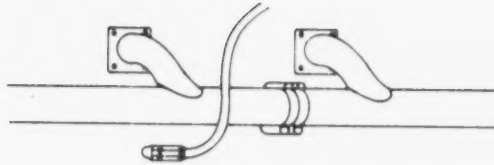


j. _____

THEORY TEST



k. _____



l. _____



m. _____

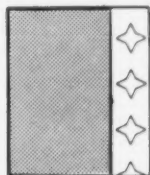


n. _____

THEORY TEST

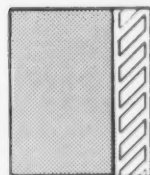
20. Match the correct fluid line names to the related fluid line symbol code. Write the correct numbers in the blanks.

_____ a.



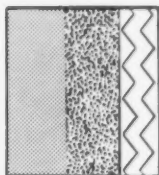
1. Compressed gas (orange, white)

_____ b.



2. Warning symbol (black, white)

_____ c.



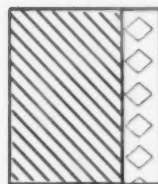
3. Fire protection (brown, white)

_____ d.



4. Fuel (red, white)

_____ e.



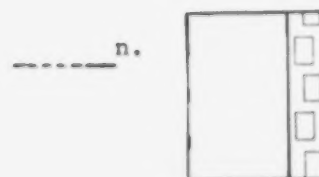
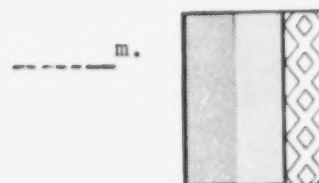
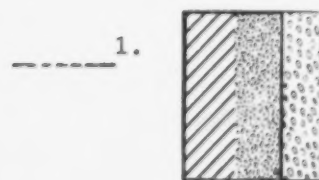
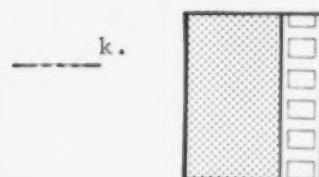
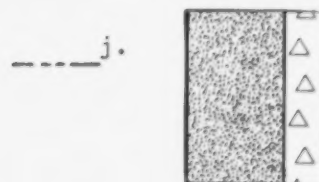
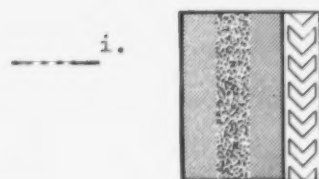
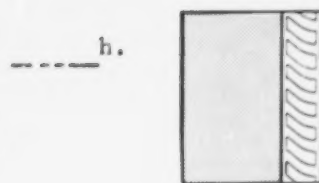
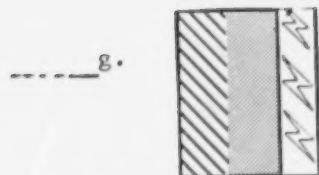
5. Instrument air (orange, gray, white)

_____ f.



6. Hydraulic (blue, yellow, white)

THEORY TEST



7. Breathing oxygen (green, white)

8. Water injection (red, gray, white)

9. Lubrication (yellow, white)

10. Electrical conduit (brown, orange, white)

11. Pneumatic (orange, blue, white)

12. Air condition (brown, gray, white)

13. Coolant (blue, white)

14. De-icing (gray, white)

THEORY TEST

(NOTE: Test question 21 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

21. Install rigid and flexible fluid lines.

GENERAL
G104 TECHNICAL MECHANICS
FABRICATE AND INSTALL RIGID AND FLEXIBLE
FLUID LINES AND FITTINGS
G104-D

ANSWERS TO THEORY TEST

- | | | | | | | |
|----|----|---|----|----|----|----|
| 1. | a. | 8 | i. | 12 | p. | 22 |
| | b. | 3 | j. | 10 | q. | 21 |
| | c. | 7 | k. | 14 | r. | 20 |
| | d. | 2 | l. | 9 | s. | 17 |
| | e. | 1 | m. | 13 | t. | 18 |
| | f. | 4 | n. | 11 | u. | 19 |
| | g. | 6 | o. | 15 | v. | 16 |
| | h. | 5 | | | | |
-
- | | | |
|----|----|---|
| 2. | a. | 1 |
| | b. | 1 |
| | c. | 2 |
| | d. | 3 |
-
- | | | |
|----|----|---|
| 3. | a. | 2 |
| | b. | 3 |
| | c. | 4 |
| | d. | 4 |
| | e. | 3 |
| | f. | 3 |
| | g. | 3 |
-
- | | |
|----|---|
| 4. | Evaluated to the satisfaction of the instructor |
| 5. | Evaluated to the satisfaction of the instructor |
| 6. | Evaluated to the satisfaction of the instructor |
| 7. | Evaluated to the satisfaction of the instructor |
| 8. | Evaluated to the satisfaction of the instructor |
| 9. | a. To connect moving parts with stationary parts in locations subject to vibrations |

ANSWERS TO THEORY TEST

- b. 1) Neoprene
2) Buna-N
3) Butyl
4) Teflon
10. a. 4
b. 1
11. a. L d. M g. M
b. H e. H
c. L f. H
12. a. 1
b. 2
c. 3
13. a. 1) Tapered pipe threads
2) Universal bulkhead fittings
b. The fittings must not be screwed in tight enough to crack the casting
c. These fittings can be oriented in exactly the correct direction and then tightened in this position so they will not leak
14. a. Blue
b. AN fittings
15. a. Plug e. Bulkhead elbow - 90°
b. Cap f. Nut
c. Union g. Adapter
d. Flareless tube elbow - 90° h. Reducer
16. a. 4 c. 1
b. 2 d. 3
17. Evaluated to the satisfaction of the instructor
18. a. 3 g. 1
b. 2 h. 1
c. 3 i. 4
d. 4 j. 4
e. 2 k. 2
f. 4

ANSWERS TO THEORY TEST

- | | | | | |
|-----|----|-----------|----|-----------|
| 19. | a. | Incorrect | h. | Incorrect |
| | b. | Correct | i. | Incorrect |
| | c. | Incorrect | j. | Correct |
| | d. | Correct | k. | Correct |
| | e. | Incorrect | l. | Incorrect |
| | f. | Correct | m. | Incorrect |
| | g. | Correct | n. | Correct |

- | | | | | |
|-----|----|----|----|----|
| 20. | a. | 4 | j. | 14 |
| | b. | 1 | k. | 7 |
| | c. | 5 | l. | 12 |
| | d. | 2 | m. | 11 |
| | e. | 3 | n. | 9 |
| | f. | 6 | | |
| | g. | 10 | | |
| | h. | 13 | | |
| | i. | 8 | | |

21. Evaluated to the satisfaction of the instructor

GENERAL
G104 TECHNICAL MECHANICS
FABRICATE AND INSTALL AND FLEXIBLE
FLUID LINES AND FITTINGS
G104-D

PRACTICAL TEST #1--Fabricate and Install Rigid and
Flexible Fluid Lines and Fittings

INSTRUCTOR'S GUIDE

- I. STUDENT ACTIVITY - The student will be required to fabricate and install rigid and flexible fluid lines and fittings in accordance with FAA and industry standards. The student must identify a common defect, use the correct references, select and use the proper tools, use the correct methods for fabrication and installation, and do this within a specified time period, using established safety practices.
- II. PREPARATION FOR TEST
 - A. Select an aircraft engine or other type of aircraft system which has both rigid and flexible fluid lines and create damage in one line of each type by using a file
 - B. Review the evaluation form
 - C. Have the student provide you with the Practical Test Guide and Evaluation Form from the Student Guide

(NOTE: For reference, a copy of the Student Guide has been placed in the Instructor's Guide.)
 - D. Fill out the Student Guide
 - E. Provide the student with the engine or system
 - F. Provide the student with a selection of possible manuals, including the required manuals, to be used in this procedure
 - G. Provide the student with a selection of possible tools, equipment, and material, including all required items, to use in the procedure
 - H. Monitor the student's performance and record the results on the evaluation form
 - I. Inspect the work at completion of both the fabrication and installation of the rigid and flexible lines
 - J. Calculate scores on evaluation form and determine student rating
 - K. Discuss the student's performance

INSTRUCTOR'S GUIDE

- L. Reteach and retest as necessary
- M. Retain the damaged sections of rigid and flexible lines for use on the projects in the next class on rigid and flexible fluid lines

GENERAL
G104 TECHNICAL MECHANICS
FABRICATE AND INSTALL RIGID AND FLEXIBLE
FLUID LINES AND FITTINGS
G104-D

PRACTICAL TEST #1--Fabricate and Install Rigid and
Flexible Fluid Lines and Fittings

STUDENT GUIDE

I. Introduction

Rigid and flexible fluid lines are the veins and arteries of an aircraft. These lines must be maintained in keeping with the highest standards unless we are willing to lose the aircraft's vital fluids. In completing this project, you will identify common defects, remove the damaged lines, fabricate identical lines, and install these lines to airworthiness standards.

II. Type of Damage Found

III. Type of Material Used in Fabricating New Lines

IV. Reference Manuals Used

V. Time at Start of Job _____

Time at End of Job _____

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NAME: _____

DATE: _____

PRACTICAL TEST EVALUATION GUIDE

PRACTICAL TEST #1--Fabricate and Install Rigid and Flexible
Fluid Lines and Fittings

Performance Evaluation Key

Student's performance is typical of an:

Point Value

A = Exceptionally competent worker	=	5
B = Above average worker	=	4
C = Average worker	=	3
D = Below average worker	=	2
E = Incompetent worker	=	1

Degree of Importance Factors

To be multiplied by performance evaluation key letter value

- 5 = Critical
- 4 = Essential
- 3 = Important
- 2 = Necessary
- 1 = Least important

(EVALUATOR NOTE: Circle the appropriate letters earned and make the necessary calculations to determine the score.)

Item No.	Process (180 pts. possible)					
	A	B	C	D	E	
1. Identified defect in rigid tubing and flexible hose assemblies	5	4	3	2	1	x 4 = _____
2. Selected and used manuals and technical publications correctly	5	4	3	2	1	x 5 = _____
3. Selected proper tools for fabrication of rigid tubing assembly	5	4	3	2	1	x 3 = _____
4. Performed fabrication of rigid tubing correctly (Used correct methods for tube cutting, bending, and flaring.)	5	4	3	2	1	x 4 = _____

PRACTICAL TEST EVALUATION GUIDE

5.	Performed installation of rigid tubing correctly (Used correct methods for torquing safetying, and securing.)	5	4	3	2	1	x	4	=	-----
6.	Selected proper tools for fabrication of the flexible hose assembly	5	4	3	2	1	x	3	=	-----
7.	Performed fabrication of the flexible hose assembly correctly (Used the correct methods for hose cutting and fitting installation.)	5	4	3	2	1	x	4	=	-----
8.	Performed installation of flexible hose assembly correctly (Used the correct methods for torquing safetying, and securing.)	5	4	3	2	1	x	4	=	-----
9.	Worked safely	5	4	3	2	1	x	5	=	-----
									Total process score =	-----
Item No.									Product (105 pts. possible)	
10.	Preinstalled condition of the rigid tubing assembly	5	4	3	2	1	x	4	=	-----
11.	Installed condition of the rigid tubing assembly	5	4	3	2	1	x	5	=	-----
12.	Preinstalled condition of the flexible hose assembly	5	4	3	2	1	x	4	=	-----
13.	Installed condition of the flexible hose assembly	5	4	3	2	1	x	5	=	-----
14.	Used time economically	5	4	3	2	1	x	3	=	-----
									Total product score =	-----
									Total process score =	-----
									Total product score +	-----
									Total test score =	-----

PRACTICAL TEST EVALUATION GUIDE

(NOTE: You must receive an "A" rating on item numbers 2, 9, 11, and 13. If those items are passed, then the acceptable passing score is 250. To determine passing score, take the average points for all items except those requiring an "A" rating. Add the total points for the required "A" ratings to the total average points.)

EXAMPLE: Items 2, 9, 11, and 13 require an "A" rating

4 items x 25 points = 100 points

10 items x 15 points = 150 points

Passing score = 250 points

MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G104 TECHNICAL MECHANICS
COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
G104-E



GENERAL
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COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
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MODULE CONTENTS

- A. Introduction and Module Objective
- B. Specific Objectives
- C. Instructor's Module Implementation Guide
- D. Technical Information Supplements
 - 1. Technical Information Supplement #1--Safety Precautions
 - 2. Technical Information Supplement #2--Special Limitations
- E. Project Guides
 - 1. Project Guide #1--Weigh Twin Engine Aircraft and Compute and Record Aircraft Weight and Balance (Platform Scales and Jacks)
 - 2. Project Guide #2--Weigh Twin Engine Aircraft and Compute and Record Aircraft Weight and Balance (Electronic Load Cells)
 - 3. Project Guide #3--Weigh Single Engine Aircraft and Compute and Record Aircraft Weight and Balance (Platform Scales and Ramps)
- F. Theory Test
- G. Answers to Theory Test

GENERAL
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COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
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INTRODUCTION

A number of forces are at work on an aircraft, such as gravity, drag, aircraft and cargo weight, and many others. For an aircraft to fly safely and efficiently these forces have to be considered and adjusted. For example, the weight of an aircraft changes during its operational life as equipment is added or removed and repairs are made. These changes affect the aircraft weight and balance information used by the pilot. Aircraft weight and balance records must be updated by the aviation maintenance technician when certain equipment changes, repairs, or alterations are made on an aircraft.

MODULE OBJECTIVE

After completion of this module, you will be able to find empty weight and center of gravity. You will also be able to perform critical fore and aft center of gravity checks, maximum weight checks, and be able to prepare load charts. You will demonstrate this knowledge by completing the procedures outlined in the workbook assignments and project guides. You will further demonstrate this knowledge by scoring a minimum of 85 percent on the module theory test.

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COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
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SPECIFIC OBJECTIVES

After completion of this module, you will be able to:

- | | | |
|--|--|---|
| 1. Match terms associated with weight and balance to their correct definitions. | EA-ITP-G
EA-ITP-GW
AC 43:13-1A | 4:II:32-34
4:14
Pages 243-250 |
| 2. List safety precautions to follow when weighing an aircraft. (3) | Technical Supplement #1 | |
| 3. Explain basic principles of weight and balance operation. (3) | AC-65-9A
EA-ITP-G
EA-ITP-GW
AC 43:13-1A | 54
4:II:28-32
4:15-23
Page 250 |
| 4. Discuss special limitations related to aircraft jacking and weight and balance. (1) | Type Certificate Data Sheet
Technical Supplement #2 | |
| 5. State the condition of aircraft certified under FAR Part 23, during the weighing operation relative to ballast, fuel, and operating fluids. (3) | EA-ITP-G
FAR 1J | 4:II:34-35
23.29 |
| 6. Perform empty weight calculation by fuel removal. (3) | EA-ITP-G | 4:II:34 |
| 7. State where to locate the leveling means of an aircraft. (3) | Type Certificate Data Sheet
EA-ITP-G | 4:II:36 |
| 8. Explain how to determine if an aircraft equipment list has been updated. (3) | EA-ITP-G | 4:II:34 |
| 9. Determine the empty-weight center of gravity relative to the main wheels of an aircraft. (3) | EA-ITP-G
EA-ITP-GW | 4:II:37-44
4:24-30 |
| 10. State where to find the maximum weight of an aircraft. (3) | Type Certificate Data Sheet | |
| 11. Calculate extreme forward and aft loading conditions. (3) | EA-ITP-G
EA-ITP-GW
AC 43:13-1A | 4:II:46-47
4:31-38
Pages 253-265 |

SPECIFIC OBJECTIVES

- | | | |
|--|--|--------------------|
| 12. Explain when placards or ballasts may be installed. (3) | EA-ITP-G
EA-ITP-GW | 4:II:44-45
4:30 |
| 13. Calculate the aircraft useful load. (3) | EA-ITP-G | 4:II:34 |
| 14. Weigh twin engine aircraft and compute and record aircraft weight and balance (platform scales and jacks). (2) | FAR 43:5
FAR 43:9
Project Guide #1 | |
| 15. Weigh twin engine aircraft and compute and record aircraft weight and balance (electronic load cells). (2) | FAR 43:5
FAR 43:9
Project Guide #2 | |
| 16. Weigh single engine aircraft and compute and record aircraft weight and balance (platform scales and ramps). (2) | FAR 43:5
FAR 43:9
Project Guide #3 | |

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INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module

A. Videotapes:

1. Importance and Principles of Aircraft Weight and Balance, ITP-G4, Program 2.
2. Center of Gravity and Loading Computations, ITP-G4, Program 3.

(NOTE: These videotapes are available from Aviation Maintenance Publishers, Inc., P.O. Box 36, 1000 College View Drive, Riverton, Wyoming 82501.)

II. Implementation Suggestions

Estimated Teaching Time		Theory	Lab
Objective 1	Explain the terms used in the weight and balance operation to a level 2 competency.		
Objective 2	Explain safety precautions to be used while securing, jacking, and weighing an aircraft. Present examples of injuries caused from unsafe work procedures.		
Objective 3	Explain the principles of the weight and balance operation and how an aircraft is to be weighed. Discuss the importance of weight and balance to a pilot during the preflight of the aircraft. Show ITP-G4, Program 2, <u>Importance and Principles of Aircraft Weight and Balance.</u>		
Objective 4	Give students a Type Certificate Data Sheet (TCDS) for a specific aircraft. Have students determine whether stress panels need to be installed before jacking the aircraft. Explain how aircraft damage can occur if needed stress panels are not installed.		
Objective 5	Have students research and discuss how to prepare a specific aircraft for the weighing operation. Be sure to discuss aircraft certificated under FAR Part 23 and aircraft not certificated under FAR Part 23.		

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objective 6	Explain the need for removing fuel from the aircraft by 1) actual removal, or 2) by total filling of the tanks and by using the fuel removal calculation after weighing the aircraft.	
Objective 7	Use a TCDS to explain the aircraft leveling process. Discuss how aircraft levels differ both longitudinally and laterally.	
Objective 8	Explain the importance of updating the aircraft equipment list before weighing. Discuss how failure to update the equipment list can prevent an accurate weight and balance calculation.	
Objective 9	Explain how to determine the actual empty weight center of gravity. Using an overhead projector or chalkboard, demonstrate how to calculate weight and balance. Show videotape ITP-G4, Program 3, <u>Center of Gravity and Loading Computations</u> . Have students complete workbook assignment EA-ITP-GW 4, pages 24-30. Assist students as necessary.	
Objective 10	Explain where an aviation maintenance technician finds the maximum weight of an aircraft and why this is important in the calculation of useful load.	
Objective 11	Explain how to calculate extreme forward and aft loading conditions. Emphasize that these calculations must fall within the manufacturer's specification range. Tell students that an aircraft cannot legally be loaded beyond this specified range.	
Objective 12	Explain that the installation of cards or ballasts may be needed if the center of gravity falls outside of the fore or aft center of gravity limit.	
Objective 13	Demonstrate how to calculate the useful load of an aircraft. Have students work several problems; assist as necessary.	

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time	Theory	Lab
Objectives 14-16	Demonstrate project guides to students and allow them to return the demonstration. Explain how to record all weight and balance data on the weighing form. Discuss the importance of the form's basic information, such as the aircraft N number, serial number, and the location of the datum. Make students aware that this information is validated by the signature of an A&P mechanic. The weighing form must also include the aircraft type, number, and date the weighing operation occurred. (NOTE: The project guide may need to be modified to meet your specific aircraft and equipment.)	

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COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
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TECHNICAL INFORMATION SUPPLEMENT #1 - Safety Precautions

(NOTE: Failure to follow these procedures may result in a life-threatening situation and aircraft damage.)

- A. Clear work area of any unnecessary equipment or materials
- B. Alert all personnel that an aircraft is being raised
- C. Select proper weight jack for aircraft to be weighed
- D. Check to see that jacks are in good working condition
- E. Be sure to place jacks firmly on a flat surface
- F. Always release aircraft brakes and remove chocks before raising or lowering aircraft
- G. Always use jack safety stops while raising aircraft
- H. Protect jack controls from accidental operation after aircraft has been raised
- I. Use weights and tail stands as specified in the manufacturer's maintenance manual

(NOTE: This is especially important if engine[s] or equipment have been removed from the aircraft.)

- J. Always weigh aircraft in a closed hangar

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TECHNICAL INFORMATION SUPPLEMENT #2 - Special Limitations

Some aircraft have special limitations on jacking and weight and balance processes. The following are areas in which special limitations may exist:

- A. Stress panels
- B. Fuel loading
- C. Fuel temperature corrections
- D. Special fixtures for aircraft jacks

To determine the correct procedures to follow regarding the above items, the following references should be consulted:

- A. Manufacturer's maintenance manual
- B. Type certificate data sheets
- C. Aircraft specification sheet
- D. Aircraft flight manual

GENERAL
G104 TECHNICAL MECHANICS
COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
G104-E

PROJECT GUIDE #1--Weigh Twin Engine Aircraft and Compute and Record
Aircraft Weight and Balance (Platform Scales and Jacks)

PURPOSE: An aircraft requires careful balance between all its forces. Weight that is too far forward will result in difficulty in slowing the aircraft for landing. Weight that is too far aft will adversely affect the stalling characteristics. Therefore, in order to promote safe and efficient flight, it is essential that the aviation maintenance technician update aircraft weight and balance records.

This project guide will assist you in jacking, leveling, and weighing an aircraft. You will also perform the actual weight and balance calculations, including extreme fore and aft and useful load checks.

REFERENCE MANUALS:

- A. Aircraft maintenance manual for your aircraft
- B. AC 43:13-1A & 2A

EQUIPMENT AND TOOLS NEEDED:

- A. Aircraft and aircraft papers
- B. Certified scales and chocks
- C. Spirit level
- D. Plumb bob
- E. Air hose
- F. Air gage
- G. Appropriate aircraft jacks
- H. 25-foot tape measure
- I. Chalkline
- J. Straightedge

PROJECT GUIDE #1

SUPPLIES AND MATERIALS:

- A. Pencil, paper, and clipboard
- B. Manufacturer's service manual
- C. Type certificate data sheets
- D. Weighing forms
- E. AC 43:13-1A & 2A

PROCEDURE:

- A. Check aircraft specifications to determine defueling procedures or special operations, if aircraft can be weighed with fuel
- B. Check aircraft for fuel, oil, and other consumable fluids to determine quantities in aircraft

(NOTE: Check manufacturer's recommendations for appropriate quantities of consumable fluids before proceeding.)

- C. Remove all items that do not have a fixed location on the aircraft

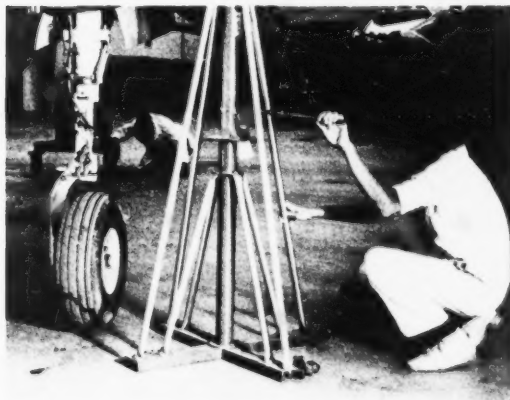
EXAMPLES: Tools, books, manuals, headsets

- D. Position jacks and personnel according to aircraft specifications; notify your instructor when you are ready to raise the aircraft

(NOTE: Always be sure to weigh an aircraft inside a closed hanger. Any amount of wind may cause incorrect readings by the scales.)

- E. Uniformly raise the aircraft (Figure 1)

FIGURE 1



PROJECT GUIDE #1

- F. Place scales under wheels of aircraft; slowly and uniformly lower aircraft onto scales (Figure 2)

(CAUTION: If jacks are not raised and lowered uniformly, the jack may tilt, which may result in possible aircraft movement or damage.)

FIGURE 2



- G. Level aircraft, using either spirit level or plumb bob as specified in TCDS or manufacturer's maintenance or flight manual, by removing air from struts as necessary (Figure 3)

FIGURE 3



PROJECT GUIDE #1

- H. Record scale readings on weight and balance form
- I. Uniformly raise the aircraft clear of the scales; remove scales (Figure 4)

FIGURE 4



- J. Uniformly lower the aircraft; install chocks (Figure 5)

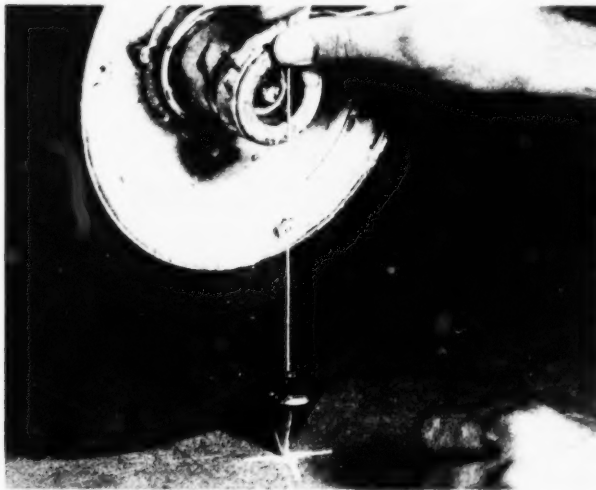
FIGURE 5



PROJECT GUIDE #1

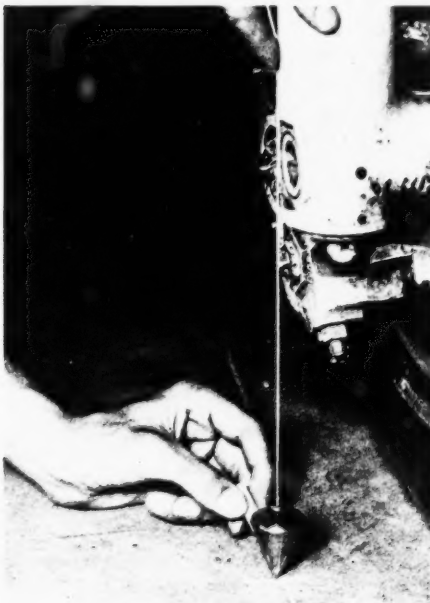
- K. Project center lines of nose gear axles, using plumb bob, to floor; mark at point of plumb bob with chalk (Figure 6)

FIGURE 6



- L. Project center lines of main gear axle, using plumb bob, to floor; mark at point of plumb bob with chalk (Figure 7)

FIGURE 7



PROJECT GUIDE #1

- M. Project two points to the floor, using the plumb bob according to manufacturer's specifications, to establish the datum (Figure 8)

FIGURE 8



- N. Move aircraft without disturbing, projected points
- O. Snap chalkline between two main gear axle chalk marks and between the two nose gear axle chalk marks to establish the reference lines (Figure 9)

FIGURE 9



PROJECT GUIDE #1

P. Measure length of main gear and nose gear reference lines (Figure 10)

FIGURE 10



Q. Establish midpoint of both reference lines (Figure 11)

FIGURE 11



PROJECT GUIDE #1

- R. Snap a longitudinal chalkline between the midpoints
- S. Snap a lateral chalkline between the datum points
- T. Measure the length of the center line between the nose gear reference line and main gear reference

(NOTE: This is the distance between the weighing points. Datum line is established so the mechanic can measure the distance from the weighing points as required.)

- U. Complete weight and balance forms
- V. Make appropriate entries into aircraft records
- W. Return equipment and materials to appropriate storage facilities

GENERAL
G104 TECHNICAL MECHANICS
COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
G104-E

PROJECT GUIDE #2--Weigh Twin Engine Aircraft and Compute and Record
Aircraft Weight and Balance (Electronic Load Cells)

PURPOSE: An aircraft requires careful balance between all its forces. Weight that is far forward will result in difficulty in slowing the aircraft for landing. Weight that is far aft will adversely affect the stalling characteristics. Therefore, in order to promote safe and efficient flight, it is essential that the aviation maintenance technician update aircraft weight and balance records.

This project guide will assist you in jacking, leveling, and weighing an aircraft. You will also perform the actual weight and balance calculations, including extreme fore and aft and useful load checks.

REFERENCE MANUALS:

- A. Aircraft maintenance manual for your aircraft
- B. AC 43:13-1A & 2A

EQUIPMENT AND TOOLS NEEDED:

- A. Aircraft and aircraft papers
- B. Certified electronic load cells
- C. Spirit level
- D. Plumb bob
- E. Air hose
- F. Air gage
- G. Appropriate aircraft jacks
- H. 25-foot tape measure
- I. Straightedge
- J. Chalkline

PROJECT GUIDE #2

SUPPLIES AND MATERIALS:

- A. Pencil, paper, and clipboard
- B. Manufacturer's service manual
- C. Type certificate data sheets
- D. Weighing forms
- E. AC 43:13-1A & 2A

PROCEDURE:

- A. Check aircraft specifications to determine defueling procedures or special operations, if aircraft can be weighed with fuel
- B. Check aircraft for fuel, oil, and other consumable fluids to determine quantities in aircraft

(NOTE: Check manufacturer's recommendations for appropriate quantities of consumable fluids before proceeding.)

- C. Remove all items that do not have a fixed location on the aircraft

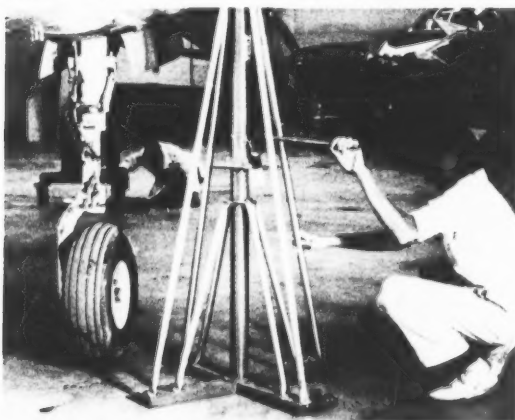
EXAMPLES: Tools, books, manuals, headsets

- D. Position jacks and personnel according to aircraft specifications; notify your instructor when you are ready to raise the aircraft

(NOTE: Always be sure to weigh an aircraft inside a closed hangar. Any amount of wind may cause incorrect readings on the scales.)

- E. Uniformly raise the aircraft (Figure 12)

FIGURE 12



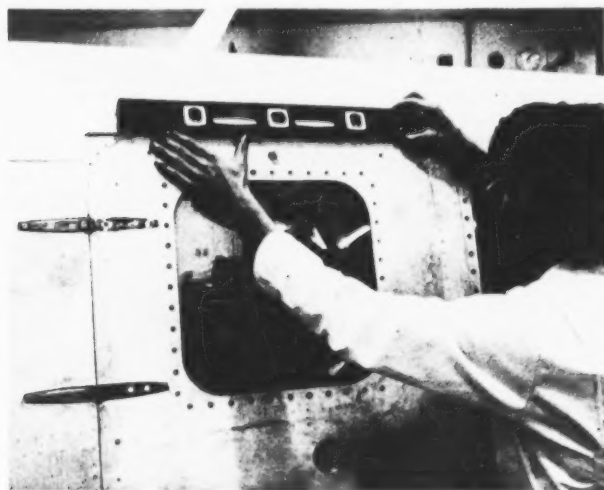
PROJECT GUIDE #2

- F. Position load cells between the jacks and aircraft jack pads

(NOTE: These load cell capsules, whose resistance changes proportionally to the load imposed on them, give an electronic readout of the aircraft weight.)

- G. Level aircraft, using either spirit level or plumb bob as specified in TCDS or manufacturer's maintenance or flight manual, by removing air from struts as necessary (Figure 13)

FIGURE 13



- H. Record scale readings on weight and balance form
- I. Uniformly raise the aircraft clear of the load cells; remove load cells

PROJECT GUIDE #2

- J. Uniformly lower the aircraft, install chocks (Figure 14)

FIGURE 14



- K. Project center lines of nose gear axle, using plumb bob, to floor; mark at point of plumb bob with chalk (Figure 15)

FIGURE 15



PROJECT GUIDE #2

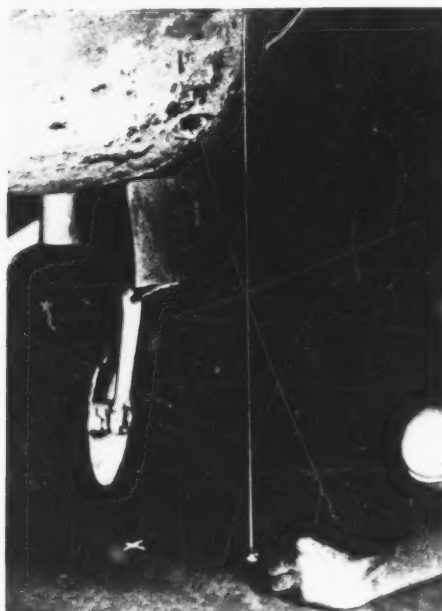
- L. Project center lines of main gear axles, using plumb bob, to floor; mark at point of plumb bob with chalk (Figure 16)

FIGURE 16



- M. Project two points to the floor, using the plumb bob according to manufacturer's specifications, to establish the datum (Figure 17)

FIGURE 17



PROJECT GUIDE #2

- N. Move aircraft without disturbing projected points
- O. Snap chalkline between two main gear axle chalk marks and between the two nose gear axle chalk marks (Figure 18)

(NOTE: Chalklines are reference lines.)

FIGURE 18



- P. Measure distance between the length of main gear and nose gear reference lines (Figure 19)

FIGURE 19



PROJECT GUIDE #2

- Q. Establish midpoint of both reference lines (Figure 20)

FIGURE 20



- R. Snap a longitudinal chalkline between the midpoints
- S. Snap a lateral chalkline between the datum points
- T. Measure the length of the center line between the nose gear reference line and main gear reference
- (NOTE: This is the distance between the weighing points. Datum line is established so the mechanic can measure the distance from the weighing points as required.)
- U. Refuel aircraft, adjust oil level, reinflate tires, and refill struts before returning to the ramp; refer to manufacturer's maintenance manual as needed
- V. Check with instructor before proceeding
- W. Complete weight and balance forms
- X. Make appropriate entries into aircraft records
- Y. Return equipment and materials to appropriate storage facilities

GENERAL
G104 TECHNICAL MECHANICS
COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
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PROJECT GUIDE #3--Weigh Single Engine Aircraft and Compute and Record
Aircraft Weight and Balance (Platform Scales and Ramps)

PURPOSE: An aircraft requires careful balance between all its forces. Weight that is far forward will result in difficulty in slowing the aircraft for landing. Weight that is far aft will adversely affect the stalling characteristics. Therefore, in order to promote safe and efficient flight, it is essential that the aviation maintenance technician update aircraft weight and balance records.

This project guide will assist you in leveling and weighing a light, single-engine aircraft. You will also perform the actual weight and balance calculations, including extreme fore and aft and useful load checks.

REFERENCE MANUALS:

- A. Aircraft maintenance manual for your aircraft
- B. AC 43:13-1A & 2A

EQUIPMENT AND TOOLS NEEDED:

- A. Aircraft and aircraft papers
- B. Certificated scales, ramps, and chocks
- C. Spirit level
- D. Plumb bob
- E. Air hose
- F. Air gage
- G. 25-foot tape measure
- H. Chalkline
- I. Straightedge

PROJECT GUIDE #3

SUPPLIES AND MATERIALS:

- A. Pencil, paper, and clipboard
- B. Manufacturer's service manual
- C. Type certificate data sheets
- D. Weighing forms
- E. AC 43:13-1A & 2A

PROCEDURE:

- A. Research aircraft specifications to determine defueling procedures or special operations, if aircraft can be weighed with fuel
- B. Check aircraft for quantities of fuel, oil and other consumable fluids to determine quantities in aircraft

(NOTE: Check manufacturer's recommendations for appropriate quantities of consumable fluids before proceeding.)

- C. Remove all items that do not have a fixed location on the aircraft

EXAMPLES: Tools, books, manuals, headsets

- D. Zero scales, weigh and record applicable tare weight on the weight and balance form (Figure 21)

FIGURE 21

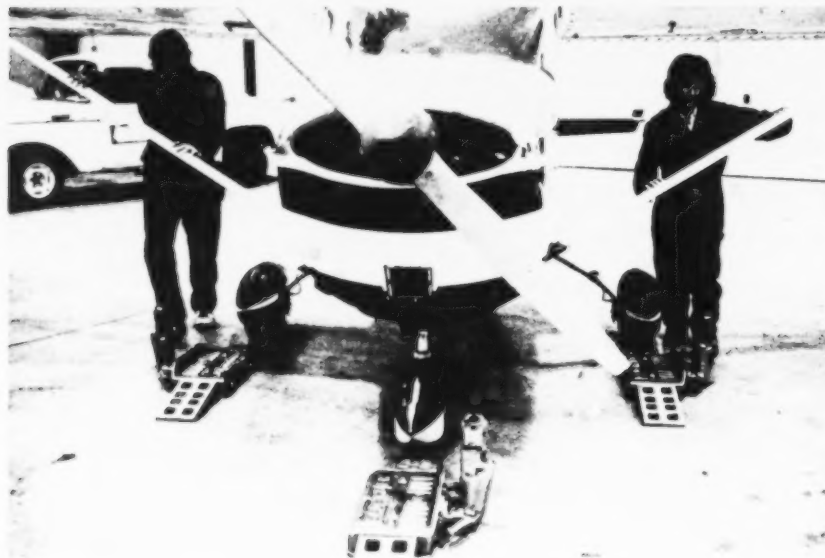


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PROJECT GUIDE #3

- E. Position personnel (one on each wing); advise your instructor that you are ready to roll the aircraft up the ramp and onto the scales (Figure 22)

FIGURE 22



- F. Slowly roll the aircraft up the ramp and onto the scales (Figure 23)
(NOTE: Be sure the aircraft wheels are centered on the scales.)

FIGURE 23



PROJECT GUIDE #3

- G. Level the aircraft as specified in the manufacturer's service manual
- H. Record scale readings on the weight and balance form
- I. Carefully remove the aircraft from the scales (Figure 24)

FIGURE 24



- J. Re-install chocks (Figure 25)

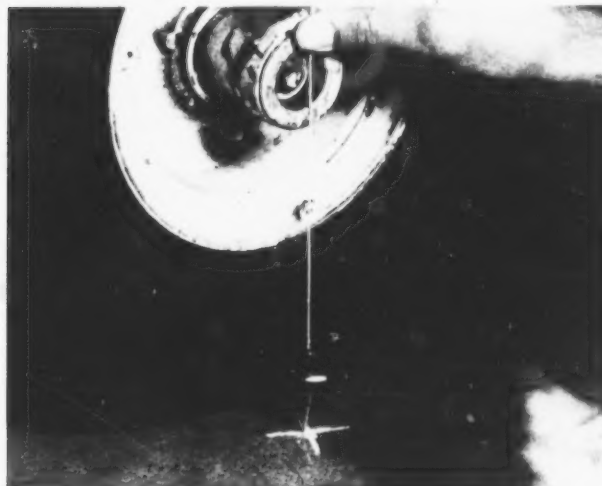
FIGURE 25



PROJECT GUIDE #3

- K. Project center lines of main gear axles, using plumb bob, to floor; mark at point of plumb bob with chalk (Figure 26)

FIGURE 26



- L. Project center lines of nose gear axle, using plumb bob, to floor; mark at point of plumb bob with chalk (Figure 27)

FIGURE 27



PROJECT GUIDE #3

- M. Project two points to the floor, using the plumb bob according to manufacturer's specifications, to establish the datum (Figure 28)

FIGURE 28



- N. Move aircraft without disturbing projected points
- O. Snap chalkline between two main gear axle chalk marks and between the two nose gear axle chalk marks (Figure 29)

FIGURE 29



PROJECT GUIDE #3

- P. Measure distance between the length of main gear and nose gear reference lines (Figure 30)

FIGURE 30



- Q. Establish midpoint of both reference lines (Figure 31)

FIGURE 31



PROJECT GUIDE #3

- R. Snap a longitudinal chalkline between the midpoints
- S. Snap a lateral chalkline between the datum points
- T. Measure the length of the center line between the nose gear reference line and main gear reference

(NOTE: This is the distance between the weighing points. Datum line is established so the mechanic can measure the distance from the weighing points as required.)

- U. Refuel aircraft, adjust oil level, reinflate tires, and refill struts before returning to the ramp; refer to manufacturer's maintenance manual as needed
- V. Check with instructor before proceeding
- W. Complete weight and balance forms
- X. Make appropriate entries into aircraft records
- Y. Return equipment and materials to appropriate storage facilities

GENERAL
G104 TECHNICAL MECHANICS
COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
G104-E

THEORY TEST

1. Match terms associated with weight and balance to their correct definitions. Write the correct numbers in the blanks.

- | | |
|--|-----------------------|
| _____ a. Aircraft approved for flight without restrictions other than those necessary as a result of flight test | 1. Arm |
| _____ b. Aircraft certificated for nonacrobatic operation | 2. Moment |
| _____ c. Aircraft intended for limited acrobatic operation | 3. Empty weight |
| _____ d. Measured horizontal distance from datum line to center of gravity | 4. Datum |
| _____ e. Point at which a body balances and the algebraic sum of the moment is zero | 5. Balance point |
| _____ f. Point at about which an aircraft would balance | 6. Center of gravity |
| _____ g. Imaginary vertical line from which all weight and balance measurements are taken | 7. Aerobatic category |
| _____ h. Weight of an aircraft, engine, and items having fixed locations | 8. Normal category |
| _____ i. Product of weight of an item times its distance from the datum | 9. Utility category |
| _____ j. Plus and minus in weight and balance | 10. Minimum fuel |
| _____ k. Fuel contained in the tanks for one-half hour of operation at rated maximum power | 11. Fuel load |
| _____ l. Usable fuel carried on an aircraft | 12. Algebraic sign |

THEORY TEST

- | | |
|--|--|
| ----- m. Maximum take-off weight less empty weight | 13. Center of gravity limits |
| ----- n. Weight of all items such as chocks or blocks that are used to hold the aircraft on the scale while it is being weighed | 14. Center of gravity range |
| ----- o. Maximum forward and aft location allowable for the center of gravity | 15. Empty-weight center of gravity range |
| ----- p. Maximum fore and aft empty-weight center of gravity locations that will not allow the legally loaded center of gravity to fall outside of the aircraft loaded center-of-gravity range | 16. Ballast |
| ----- q. Distance between fore and aft center of gravity limits | 17. Tare |
| ----- r. Weight that is installed in the aircraft to bring the center of gravity into range | 18. Useful load |
| ----- s. Scaled reading less tare weight | 19. Net weight |
| ----- t. Fuel in the aircraft system that will not flow in normal flight attitudes | 20. Station |
| ----- u. Location expressed in inches from the datum | 21. Unusable fuel |
| ----- v. Method specified by the manufacturer to properly level an aircraft | 22. Leveling means |

2. List safety precautions to follow while weighing an aircraft.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____

THEORY TEST

- h. _____
- i. _____
- j. _____
3. Explain basic principles of weight and balance operation.

4. Discuss special limitations related to aircraft jacking and weight and balance.

5. State the condition of an aircraft, certificated under FAR Part 23, during the weighting operation relative to ballast, fuel, and operating fluids.
- a. Ballast -- _____
- b. Fuel -- _____
- c. Hydraulic fluid -- _____
- d. Oil tank -- _____
- e. Other operating fluids -- _____
6. Using the following specifications, perform empty weight calculations by fuel removal.

Aircraft A was weighed with full fuel.
Aircraft weight: 1,285 pounds
Aircraft moment: 57,600 pound-inches
Fuel is located: 11" aft of datum
Fuel: 24 gallons AVGAS

THEORY TEST

- a. What is the empty weight? _____
- b. What is the empty weight moment? _____
- c. What is the new empty weight center of gravity? _____

7. State where to locate the leveling means of an aircraft.

8. Explain how to determine if an aircraft equipment list has been updated.

9. Using the following specifications, determine empty-weight center of gravity relative to the main wheels of an aircraft.

Aircraft specifications:

Tail wheel--100 pounds

Left main--380 pounds

Right main--390 pounds

Distance from main to tail--100 inches

Empty-weight center of gravity-- _____

10. State where to find the maximum weight of an aircraft.

11. Using the following specifications, calculate the extreme forward and aft loading.

Aircraft specifications:

Center of gravity range is +29 to +38 inches

65 horsepower engine

Empty-weight 700 pounds

Empty-weight center of gravity +36.5 inches

Front seat located at +28 inches

Rear seat located at +56 inches

(NOTE: Aircraft can be piloted from either seat.)

16 gallons of AVGAS located at +26 inches

1.5 gallons of oil located at -6 inches

No baggage compartment

THEORY TEST

- a. What is the forward extreme loading condition weight and center of gravity? _____
- b. What is the rearward extreme loading condition weight and center of gravity? _____
- c. What is the maximum loaded weight? _____
12. Explain when placards or ballasts may be installed.
- _____

13. Using the following aircraft specifications, calculate the aircraft useful load.

Aircraft specifications:

Maximum weight: 34,205 pounds

Empty weight: 21,000 pounds

Useful load _____

(NOTE: Test questions 14-16 are project guides. They are an important part of this test. If they have not been completed, check with your instructor.)

14. Weigh twin engine aircraft and compute and record aircraft weight and balance (platform scales and jacks).
15. Weigh twin engine aircraft and compute and record aircraft weight and balance (electronic load cells).
16. Weigh single engine aircraft and compute and record aircraft weight and balance (platform scales and ramps).

GENERAL
G104 TECHNICAL MECHANICS
COMPUTE AND RECORD AIRCRAFT WEIGHT AND BALANCE
G104-E

ANSWERS TO THEORY TEST

- | | |
|---------|-------|
| 1. a. 7 | l. 11 |
| b. 8 | m. 18 |
| c. 9 | n. 17 |
| d. 1 | o. 13 |
| e. 5 | p. 15 |
| f. 6 | q. 14 |
| g. 4 | r. 16 |
| h. 3 | s. 19 |
| i. 2 | t. 21 |
| j. 12 | u. 20 |
| k. 10 | v. 22 |
2. a. Clear work area of any unnecessary equipment or materials
- b. Alert all personnel that an aircraft is being weighed
- c. Select proper weight jack for aircraft to be weighed
- d. Check to see that jacks are in good working condition
- e. Be sure to place jacks firmly on a flat surface
- f. Always release aircraft brakes and remove chocks before raising or lowering aircraft
- g. Always use jack safety stops while raising aircraft
- h. Protect jack controls from accidental operation after aircraft has been raised
- i. Use weights and tail stands as specified in the manufacturer's maintenance manual
- j. Always weigh aircraft in a closed hangar
3. Weight and balance control consists of mathematical proof of the correct weight, balance, and loading within specified limits
4. Discussion should include the following
- Some aircraft have special limitations on jacking and weight and balance processes. The following are areas in which special limitations may exist:

ANSWERS TO THEORY TEST

- a. Stress panels
- b. Fuel loading
- c. Fuel temperature corrections
- d. Special fixtures for aircraft jacks

To determine the correct procedures to follow regarding the above items, the following references should be consulted:

- a. Manufacturer's maintenance manual
 - b. Type certificate data sheets
 - c. Aircraft specification sheet
 - d. Aircraft flight manual
5. a. Ballast -- Fixed and installed
b. Fuel -- Drained; except unusable fuel
c. Hydraulic fluid -- Full
d. Oil tank -- Full
e. Other operating fluids -- Full
6. a. Empty weight: 1,141 pounds
b. Empty weight moment: 56,016 pounds-inches
c. Empty-weight center of gravity: 49.09 inches aft of the datum
7. Type certificate data sheet (TCDS)
8. Physically inspect aircraft equipment; compare to the equipment list found in the aircraft records
9. 11.5 inches aft of main wheels
10. Type certificate data sheet (TCDS)
11. a. Most forward check: 977 pounds and 33.5 inches
b. Most rearward check: 914 pounds and 39.2 inches
c. Maximum check: 1147 pounds
12. When the extreme conditions check limit would be exceeded

ANSWERS TO THEORY TEST

13. 13,205 pounds
14. Evaluated to the satisfaction of the instructor
15. Evaluated to the satisfaction of the instructor
16. Evaluated to the satisfaction of the instructor